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JAN 80 S MAEKAWA, O FURUYA N00014-79-C-0234
UNCLASSIFIED TETRAT-TC-3284-02 NL

1 OF 3
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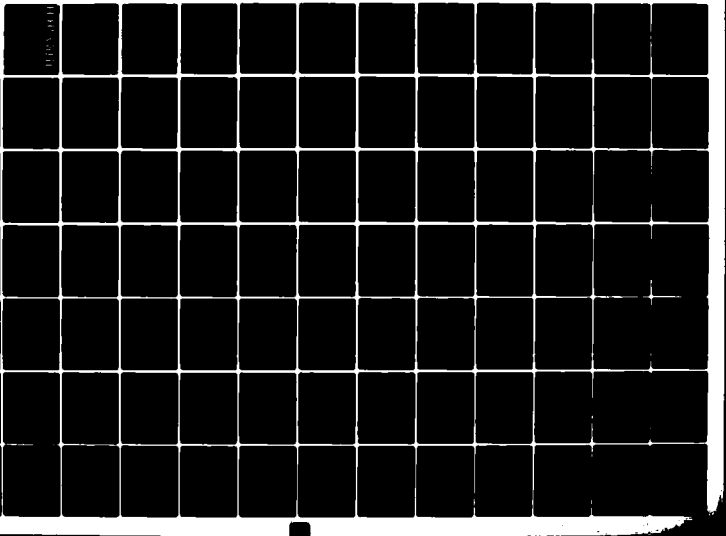

Report No. TC 3284-02
Contract No. N00014-79-C-0234 (GHR Program)

COMPUTER PROGRAMS FOR CALCULATING PARTIALLY CAVITATING BLUNT TRAILING EDGED CASCADE FLOWS IN NONLINEAR THEORY

by

Shin Maekawa
Okitsugu Furuya

TETRA TECH, INC.
630 NORTH ROSEMEAD BOULEVARD
PASADENA, CALIFORNIA 91107

Prepared for

DAVID W. TAYLOR NAVAL SHIP RESEARCH
AND DEVELOPMENT CENTER
BETHESDA, MARYLAND 20084

OFFICE OF NAVAL RESEARCH
800 NORTH QUINCY STREET
ARLINGTON, VIRGINIA 22217

JANUARY 1980

TETRA TECH

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number):
In addition to the previously developed partially cavitating cascade theory, two new flow models were constructed in search of a better flow model for determining accurate force coefficients. Effort has been made for obtaining (1) physically acceptable flows, particularly the location of cavity boundary and (2) smooth matching of the flow characteristics between the partially cavitating and super-cavitating flow regimes. Based on the numerical results made with these flow models for practical blade profiles taken after a supercavitating propeller it was found that no single flow model developed above could handle the complete set of →

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20. cascade geometries and incidence angles. One theory was supplemental to the other and no definite guideline was discovered for selection of an appropriate flow model for a specified flow condition to be solved except for a few weak evidences.

This report is a users' manual for the computer programs developed above, describing the structure of program, input data set-up, typical output data and listing.

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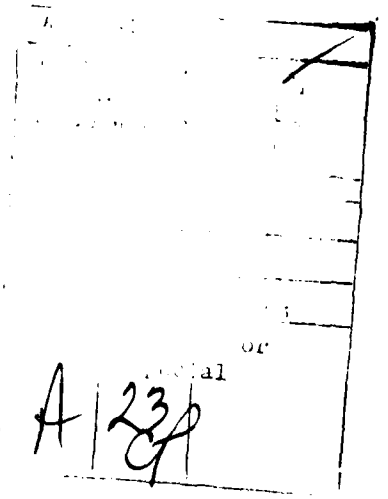

1.0 INTRODUCTION

Three computer programs were developed under the present work (see [1]). Two of these programs, PCASE and PCASLE, used the open wake models, whereas the third one, PCASLDW, used the double wake model of the partially cavitating cascade flow. PCASE requires the cavitation number, and PCASLE and PCASLDW require the cavity length as input data. The detailed explanations in regard to the type of model used for these programs are given in [1]. The general rule of thumb is that if the cavity length is short and/or the negative camber on the suction side of the cascade is small, PCASE converges rapidly, whereas if the cavity length becomes long and/or the negative camber on the suction side of the cascade is large, PCASLE provides a better convergence. PCASLDW may be used when the pressure-side camber is large so that the calculated cavity boundary tends to intersect the upper surface of the blade in the supercavitating cascade flow configuration.

Six solution parameters are to be determined for PCASE: these include three transform coordinates, scaling factor for mapping, deflected flow angle at downstream infinity, and ratio of flow passage width at downstream infinity to that at upstream infinity. For PCASLE, one extra solution parameter, i.e., cavitation number is added, making the total number of solution parameters seven. For PCASLDW, one of the solution parameters, i.e., ratio of flow passage at downstream infinity to upstream infinity, was deleted, but two new solution parameters, i.e., two transform coordinates, were introduced, making the total number of solution parameters eight. PCASLDW requires the most computer time of the three to carry out one iteration due to the increased total number of solution parameters.

In the following, the structure of the program including various subroutines, input data set-up, typical output data and

listings of these three programs is described. Due to the similarity in the input data set-up of the programs, only that of PCASE is given completely. It is believed that there will be no difficulty in running PCASLE and PCASLDW once one becomes familiar with PCASE.

2.0 STRUCTURE OF PCASE

PCASE consists of a main program and several subroutines, brief descriptions of which will be given as follows:

1) MAIN PROGRAM PCASE

- o Specify the dimensions for data.
- o Read input data.
- o Exercise Newton's iterative procedure.
- o Calculate lift and drag coefficients at the end of each iteration.
- o Calculate the cavity profile.

2) SUBROUTINE OXFNEW(X,STOL,M,I,DG,DF,FFF4)

- o Exercise Newton's iterative procedure in calculations for the six integral equations to find the six unknown solution parameters.

x: Input and output data in array SXSI(I)

SXSI(1): ξ - coordinate for the point B of the foil.
SXSI(2): ξ - coordinate for the point C.
SXSI(3): ξ - coordinate for the point F.
SXSI(4): $\tilde{A}$, coefficient of the mapping function.
SXSI(5): α_2, downstream flow angle.
SXSI(6): ε - ratio of d_2 to d_1

STOL: Control variables for the accuracy of Newton's iterations.

M: Number of desired iterations for Newton's procedure.

I: Counts the number of iterations of Newton's procedure. This is defined within OXFNEW.

DG: This is one of the assigned finite differences for the numerical derivations of $\frac{\partial f}{\partial x}$. However, it is no longer used in the calculations themselves as it has been replaced by the array DELI(I,J) which is read in at the beginning of the program.

DF: Same as DG.

FFF4: The residue of equation F(4); if FFF4 becomes larger than S4 of input data, the program is stopped.

3) SUBROUTINE OFSIM1 (ANS,NOF,XCA)

- o Calculates integral I(1) of integral equation F(1) for special ease of foil shape with rounded left end. Called from subroutines: F1INTL, RMINT, CAVITY (see Reference [1] for F(1)).

ANS: Final answer for the integral I(1) of equation F(1).

NOF: This is a controlling variable passed on from the calling subroutines:

NOF = 0 - OFSIM1 called from F1INTL
NOF = 1 - OFSIM1 called from RMINT for real part
NOF = 2 - OFSIM1 called from RMINT for imaginary part
NOF = 3 - OFSIM1 called from CAVITY OXFNEW at F(5)

XCA: Integration variable passed on to OFSIM1 only if NOF = 3.

4) SUBROUTINE OFSIM2 (ANS2)

- o Controls iterative procedure for calculating integral equation F(4). Called from OXFNEW (see Reference [1] for F(4)).

ANS2: Final answer of OFSIM2

5) SUBROUTINE OFSIM3 (Y,XXII,IP,I)

- o Calculates $g_1(\xi)$ in integral equation F(4). Called from OFSIM2. (see [1] for $g_1(\xi)$).

Y: Integration variable passed from OFSIM2, corresponding to ξ.

XXII: Returns value of $g_1(\xi)$ to OFSIM2. The parameter is passed from OFSIM2 to OFSIM3 in the form of one element of an array (XITC(I)) inside an iterative loop.

IP: Number referring to the control point; IP = 1 to LPM.

I: I = 2 for the subdivided middle point between the regular control points specified by IP; I = 3 for the control points.

6) SUBROUTINE OFSIM5(ANS5)

- o Calculates values of F(5) using Simpson's rule and Chebyshev-Gauss polynomials.

ANS5: Value returned to loop in OXFNEW for equation F(5).

7) SUBROUTINE F1INTL (YINT, KCTRL)

- o Calculates integrals in integral equation F(1). Called from OXFNEW.

YINT: Value returned for integral each time F1INTL is called.

KCTRL: Control variable passed from OXFNEW directing which of the four integrals in F(1) is to be calculated. (see [1]).

8) SUBROUTINE G2(XS2,AG2,IS2)

- o Calculates g_2 (ξ) in F(5) given integral variable ξ, i.e., XS2. Called from iterative loop in OFSIM5.

XS2: Abscissa subdivision points from which g_2 (ξ) are calculated, i.e., ξ.

AG2: Value for g_2 (ξ) returned to OFSIM5 after each time it is called.

IS2: Number of control points on the second arc S2.

9) SUBROUTINE RMINT(SR,SM,MIQ)

- o Calculates r_1, r_2, r_3, r_4; m_1, m_2, m_3, m_4 of equations F(2) and F(3) respectively. These values are used to calculate F(2) and F(3) in OXFNEW (see [1]).

SR: Value for r returned to OXFNEW

SM: Value for m returned to OXFNEW

MIQ: Control variable passed from OXFNEW dictating which value (1, 2, 3 or 4) of r or m is to be calculated.

10) SUBROUTINE CAVITY (XCC, YCC)

- o Calculates coordinates of points along cavity cross-section to give cavity shape. Passes cavity endpoint coordinates back to OXFNEW.

XCC: Value returned to OXFNEW for x coordinate of cavity endpoint.

YCC: Value returned to OXFNEW for y coordinate of cavity endpoint.

11) SUBROUTINE IC2(SR,SM,XCA, ISIC)

- o When ISIC = 0 used to calculate r_4 and m_4 of equations F(2) and F(3) respectively. It is then called from OXFNEW. When ISIC = 1 it is used to calculate.

SR,SM: When called from RMINT this is the returned value for r_4 and m_4. When called from CAVITY, only SR is used and SM becomes dummy (see Reference [1]).

XCA: Only used for ISIC = 1, integration variable.

ISIC: This is a control variable which tells IC2 whether to do calculation for OXFNEW or for OFSIM5 or CAVITY.

= 0 called from RMINT.

= 1 called from CAVITY IN OFSIM5 for F(5).

12) SUBROUTINE MOSEC (A,B,ER1,X,J,XLPA,IS1I2)

- o Finds a root of f(x) = 0 where x must lie between A and B and f(A)>0, f(B)<0.

A.B: A root of f(x) = 0 exists between A and B.

ER1,ER2: Accuracy controlling variables where $|x_{real} - x| < ER1$ and $|f(x_{real}) - f(x)| < ER2$.

x: A root of f(x) = 0, found in this subroutine and returned to the calling program.

J: Number of iterations done in MOSEC.

13) FUNCTION AITKEN(XX,YY,X,N)

- o Interpolate the value corresponding to X with the data of XX(N), YY(N) specified by Aitken method.

14) SUBROUTINE DETERM (A,N,D)

- o Calculates determinant of a matrix A of rank N

A: Matrix input, requiring dimension.

N: Rank of the matrix.

D: Calculated determinant of A.

15) SUBROUTINE ARCS2 (S2,XC,YC)

- o Calculates the arc length of the upper wetted portions S2. Called from OXFNEW in calculations for F(5) after the CAVITY subroutine.

S2: returned arc length of arc S2.

XC: X-coordinate of cavity endpoint.

YC: y-coordinate of cavity endpoint.

16) SUBROUTINE ARCLEN (XSS,XL,XH,IS1I2)

- o Calculates arc length of small intervals between XL and XH along foil profile.

XSS: Returned arc segment length.

XL: Lower x coordinate of segment endpoint.

XH: Upper x coordinate of segment endpoint.

IS1I2: Control variable telling the routine whether the upper or lower edge of the foil is to be looked at; IS1I2 = 0 for the lower edge, IS1I2 = 1 for the upper edge.

17) SUBROUTINE XCYC (XCB,YCB,CX,CY)

- o Calculates the point on the upper face of the foil corresponding to the endpoint of the cavity.

XCB: X-coordinate of returned point on foil.

YCB: Y-coordinate of returned point on foil.

CX: X-coordinate of cavity endpoint.

CY: Y-coordinate of cavity endpoint.

18) SUBROUTINE BBBETA (XX,RBETA, IS1I2)

- o Calculates BETA(X(XSI))

XX: X-coordinate of the body for which the local body slope RBETA to be calculated.

RBETA: Local body slope in radians calculated in this subroutine.

IS1I2: Control variable; = 0 for the lower portion

19) SUBROUTINE FARC (FAR, XLPA,X1B,IS1I2)

- o Calculates the difference between the arc length DSS and that corresponding the ξ-coordinates of XLPA and X1B.

IS1I2: The same as that in BBBETA.

20) SUBROUTINE SHAPE (X,Y,BETA,IS1I2)

- o Calculates points along cross-section of foil to give shape of foil. Also gives the angle of the tangent to the foil at each point.

X: X-coordinate for which Y and BETA to be calculated.

Y: Y-coordinate of calculated point.

BETA: Angle of tangent to the foil at calculated point.

IS1I2: Control variable to tell the subroutine whether to look at the upper or lower face of the foil.

21) SUBROUTINE FC2 (T,F,XL,XH,IS1I2)

- o Calculates values of the function along the wetted arc to be integrated in the subroutine ARCLEN.

T: Value to be calculated at.

F: Value of the function.

XL: Low limit of the integration.

XH: Upper limit of the integration.

IS1I2: Control variable; = 1 for sharp leading edge
= 0 for round leading edge

3.0 INPUT DATA

The following data are those for the family program of PCAS (Partially Cavitating Cascade Cases) which include PCASE, PCASLE, and PCASLDW. Formatting examples are shown in Section 3.1. Several data cards must be changed in order to run the different version of PCAS.

It is important to note that these programs, particularly PCASLDW, were written to be able to handle blunt trailing edged foils properly. Readers are advised to see [3] for the cases having sharp trailing edges. The input data set-ups shown below are those for calculating the two-dimensional loadings for a partially cavitating propeller. The input parameters representing the propeller blade configurations include R, AAAA, to CCCC, A8 to D8 XROUND and A2AA to C2CC. The definition of these parameters is described in [1]. The thickness of the foil which was used for the plano-convex foil case in the previous project [1] is now a dummy input in these programs.

3.1 INPUT DATA FOR PCASE

DATA CARD NO.	SYMBOL	DESCRIPTION	FORMAT
1	NGAUS	Number of subdivisions used in Gaussian integration.	I10
2-4	TGAUS(I)	Abscissas of Gaussian integration.	4F20.10
5-7	WGAUS(I)	Weight factors of Gaussian integration.	4F20.10
8	XXM	Weighting factor for solution parameters in iterative procedure (0 to 1).	F10.8
9-14	DELT(I,J)	Increment for numerical calculations of partial derivatives.	6F10.8
15	TH	The thickness in percent of the plano-convex foil (dummy variable).	3F20.10
	XXDD	End of the normalized foil = 1.	
	YYDD	Y coordinate of upper end of the normalized foil.	
16	R	Specifies the radial location on the propeller blade (normalized to be unity at the tip)	4F20.10
	AAAA,BBBB,CCCC	Coefficients for terms in the equation of the cross-sectional shape of the lower face of the propeller blade. These coefficients are used in the second equation for x values along the cross-section where $.2 \leq x \leq .8$ (see Reference 2 for the form of equation).	

17	A8,B8,C8,D8	Coefficients for third equation of cross-sectional shape of the lower face of the blade where $x \leq .8$ (see [2] for the form of equation).	4F20.10
18	XROUND	Leading edge radius. This is actually used only when ISHARP = 1 (rounded leading edge). Otherwise it is a dummy variable.	4F20.10
	A2AA,B2BB,C2CC	Coefficients for first equation of cross-sectional shape of the lower face of the blade where $x \leq .2$ (see [2] for the form of equation).	
19	AAAAU,BBBBU,CCCCU	Coefficients for second equation of cross-sectional shape of the upper face of the blade where $.2 \leq x \leq .8$ (see [2] for the form of equation).	4F20.10
20	A8U,B8U,C8U,D8U	Coefficients for third equation of cross-sectional shape of the upper face of blade where $x \geq .8$ (see [2] for the form of the equation).	4F20.10
21	A2AAU,B2BBU,C2CCU	Coefficients for first equation of cross-sectional shape of the upper face of blade where $x \leq .2$ (see [2] for the form of the equation).	4F20.10
22	IFLAG1	= 0 - for regular runs $\neq$ 0 - for runs reading data from CASCLIM. Needs extra data for SXSI(2), SXSI(3).	2I10
	NCHBY	The number of Chebyshev-Gauss control points.	
23	SBETA	Initial angle of incidence for a starting flat plate solution in degrees.	5E14.7
	SBETA2	Body angle of a flat plate in degrees. Used as an initial solution.	

	SF4	Always set = 10. Used to stop computation if the calculated arc length S1 becomes larger than SF4.	
	BETAB	Body angle at point B.	
	BETAC	Body angle at point C. (initially assumed value)	6I8
24	LPMS	Number of control points over the ξ coordinates between ξ = -1 and b. Used for first arc length S1. (see Reference [1]).	
	LPKS	Number of subdivisions between ξ = b and the last point of the coarse division made by LPMS.	
	LPM2	Same as LPMS only used for calculations on second arc length S2. Note that there is only 1 segment spacing here.	
	IFLAG	= 1 - for first run which requires data to be fed in, i.e., but only SXSI(1) to SXSI(5).	
		= 0 - for use of previous data in which case data will be read either from a data card (if IREAD = 5) or from tape (if IREAD = 1). For IREAD = 5, not only SXSI(1) to SXSI(5) but also SARC(I), BETAN(I): SARC2(I), BETA2 must be read from the data card.	
	IREAD	Used for controlling where data is read from. Either tape or card as above.	
	ISHARP	= 0 - for sharp leading edge. = 1 - for rounded leading edge.	
25	NITER	Number of flow configurations to be calculated in 1 run.	4I8

	MSTOP	Number of iterations to stop the larger nest.	
	MAXIT	Number of iterations for Newton's loop.	
	NHK	Control index for varying either the set values of the angle of incidence, solidity, or cavitation number, depending on 1, 2, or 3, respectively for the NITER loop.	
26	ALFA1S	Flow incidence angle in degrees (see Figure 1).	4E14.7
	GAMMAS	Cascade geometric stagger angle in degrees (see Figure 1)	
	SOLIS	Solidity of the cascade (= $^{c}/_{s}$ in Figure 1)	
	SIGMS	Cavitation number = $(p_1 - p_c)/\frac{1}{2}\rho V_1^2$	
27	DE,DG,DF	Finite differences for numerical derivations of $\frac{\partial f}{\partial x}$ in subroutine OXFNEW. These are replaced by DELT(I,J), no longer used.	3E14.7
28	SXSI(I), I = 1,6	This card is necessary only if IFLAG = 1; SXSI(I), I = 1,6 correspond to b, c, f, $\tilde{A}$, α_2, and ε. Values for SXSI(I) must be arbitrarily assumed and tried to see if a convergent solution is obtained.	6E13.6
29	SARC(1), BETAN(1)	Arc length vs. local incidence angle in radians for the lower portion of the body; these data are needed only if IFLAG = 0 and IREAD = 5.	2E14.7
	/		
29 + LPM	SARC(LPM), BETAN(LPM)		

30 + LPM SARC2(1) BETAN2(1) / 30 + LPM + LPM2 SARC2(LPM2) BETAN2(LPM2)	Arc length vs. local incidence angle in radians for the upper portion of the body; these data are needed only if IFLAG = 0 and IREAD = 5.	2E14.7

3.2 INPUT DATA FOR PCASLE

Several input cards change from those of PCASE. Only the changes are noted here.

DATA CARD NO.	SYMBOL	DESCRIPTION	FORMAT
9-14	DELT(I,J)	Increment for numerical calculations for partial derivatives.	7F10.8
26	ALFA1S	Flow incidence angle in degrees (see Figure 1).	4E14.7
	GAMMAS	Cascade geometric stagger angle in degrees (see Figure 1).	
	SOIIS	Solidity of the cascade (= c/s in Figure 1).	
	CAVLEN	Specified cavity length (= ℓ_c in Figure 1).	
28	SXSI(I),I = 1,7	This card is necessary only if IFLAG = 1; SXSI(I), I = 1, 7 correspond to b, c, f, A, α_2, σ, and ε.	7F10.7

3.3 INPUT DATA FOR PCASLDW

Several input cards change from those of PCASE. Only the changes are noted here.

DATA CARD NO.	SYMBOL	DESCRITPION	FORMAT
9-15	DELT(I,J)	Increment for numerical calculations for partial derivatives.	8F10.8
26	ALFA1S	Flow incidence angle in degrees (see Figure 2).	4E14.7
	GAMMAS	Cascade geometric stagger angle in degrees (see Figure 2).	
	SOLIS	Solidity of the cascade (= c/s in Figure 2).	
	CAVLEN	Specified cavity length (= ℓ_c in Figure 2).	
28	SXSI(I),I=1,8	This card is necessary only if IFLAG = 1; SXSI(I),I = 1, 8 correspond to b, c, f, $\tilde{A}$, α_2, σ, g, and h.	8F10.7

3.4 TYPICAL DATA SET-UP FOR PCASE

```
PCASCAD,P7,T100,CM120000.504833,MACKA,A
FETCHPS,PCASCH,LGO,PROP.
FETCHPS,PCASCA,TAPE1,PC017.
LGO.
ENTERPS,PCASCA,TAPE7,PC017.
REWIND,TAPE7.
COPYSBF,TAPE7,OUTPUT.
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      1       1        4      1
          3.       53.63           .435          .9
       1.E-7          1.E-3          1.E-5
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3.5 TYPICAL DATA SET-UP FOR PCASLE

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PCASLE7,P7,T200,CM120000.304633,MAEKA.A
FETCHPS,PCASLE7,LGO,PCLE7.
FETCHPS,PCASLE7,TAPE1,PL004.
LGO.
ENTERPS,PCASLE7,TAPE7,PL004.
REWIND,TAPE7.
COPYSBF,TAPE7,OUTPUT.

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       0.7
   .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
   .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
   .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
   .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
   .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
   .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
   .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
                    0.                  1.                  0.
0.5                 0.01193             -0.0602553          -0.0041395
0.1034867           -0.4542559          0.5308437           -0.2476161
0.0000955           -0.0658112          0.1579089           -0.3673004
.0070331            .0043799            .0372023
-.0399177           .2145551            -.1862176           .0511030
.1551705            -.6395237           1.0609821
        40
            0.         -130.            10.        -130.        -180.
       71        30        40                1
        1         1         5         1
            4.         43.33          .535          .35
          1.E-7         1.E-3         1.E-5
.00035026 .02656057 .06225021 .02733555 -.0649531 .35000000 .3570967
```

3.6 TYPICAL DATA SET-UP FOR PCASLDW

```
PCAS.9,P7,T300,CM120000.504302,MAEKAWA
FETCHPS,PCAS.9,LGO,PC9.
FETCHPS,PCASC9,TAPE1,PW003.
LGO.
ENTERPS,PCASC9,TAPE7,PW004.
REWIND,TAPE7.
COPYSBF,TAPE7,OUTPUT.
EXIT.
EXIT.
DUMP,0.
FIN.
FILES,L=ZZTAP.
FETCHPS,DFM,DFM,DFM.
CALL,DFM.
                                                                                                  ..

        20
         .0755265211         .2277858511         .3737060987         .5108670 2
         .6360536307         .7463319065         .8391169718         .9122344263
         .9539719273         .9931255992
         .1527533571         .1491729865         .1420961093         .1316586384
         .1131945320         .1019301196         .0832767415         .0625720483
         .0406014293         .0175140071
      0.7
  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001  .0000001
0.6                 0.0153502           -0.0669965          0.0054432
0.1345763           -0.5573011          0.6723851           -0.3152717
0.0000312           -0.0223314          -0.0138033          -0.0607203
.0033642            .0021305            .0328911
.0355433            -.2703552           .3818481            -.1733240
.1636632            -.5339753           .3526987
        40
            0.          -130.           10.        -130.       -180.
      71        30       40                1
       1         3        4        1
            2.       53.63              .485              .98
          1.E-7         1.E-3           1.E-5
1.00
                                                                                                  ..
..
```

4.0 OUTPUT DATA

Most of the output are self-explanatory, however, those not explained in output data are described as follows:

T(I):	This is just a repetition of the input data TGAUS(I).
W(I):	Repetition of input data WGAUS(I).
X(I):	Solution parameters corresponding to SXSI(I). Each time these appear they are an updated version of those preceding them.
CAV(X):	This gives the x-coordinate of the cavity endpoint.
CAV(Y):	This gives the y-coordinate of the cavity endpoint.
P(I,J):	Partial derivatives of Function F(I) used for Newton's method.
YINT4:	Solution to 4th integral of equation F(1).
SOLNR & SOLNM:	Intermediate calculated values of integrals, only used for checking the numerical accuracy.
F(X):	Residue of each function F(1)...F(8)
SXSI(I):	Solutions.
CLINF:	Lift coefficient at infinity.
CDINF:	Drag coefficient at infinity.
CCDD:	Drag coefficient.
CCLL:	Lift coefficient.
L/D:	Cavity length to chord ratio.
BIGS2:	Arc length of the face of the foil. Either upper or lower face.
XCCC:	x-coordinate of cavity endpoint.
YCCC:	y-coordinate of cavity endpoint.

XS2D: Intermediate values used as a check for progress of program. Can be ignored.

XKSI: Intermediate values used as a check for progress of program. Can be ignored.

XXX2: x-coordinate distance from the leading edge.

SARC2: Distance from the leading edge along the upper surface of foil at XXX2.

CP2: Normalized pressure at the upper surface of foil at XXX2.

BBTAN2: Slope of the upper surface of the foil surface at XXX2.

XXX: x-coordinate distance from the leading edge.

SARC: Distance from the leading edge along the lower surface of foil at XXX.

CP: Normalized pressure at the lower surface of foil at XXX.

BETAN: Slope of the lower surface of the foil at XXX.

4.1 TYPICAL OUTPUT DATA

```
LOAD MAP.                                     LINK - EKY 6000/7000 8.4        20 JUL 79 16.06.47
BLOCK ASSIGNMENTS.

BLOCK            ADDRESS     LENGTH    FILE

F[illegible]SYS=       42575        540    FTN4LIB
 /[illegible]VERL[illegible]/     43435          1
F[illegible]RUTL=        43436         16    FTN4LIB
F[illegible]         43454        120    FTN4LIB
F.READF=         43574        170    FTN4LIB
F.RE.            43764         41    FTN4LIB
F.[illegible]EIF         44025         52    FTN4LIB
F.[illegible]ITF         44077        172    FTN4LIB
[illegible]ITF=       44231         43    FTN4LIB
[illegible]         44264         60    FTN4LIB
[illegible] =          44344        260    FTN4LIB
[illegible]=             44606        234    FTN4LIB
[illegible]=          45062        576    FTN4LIB
[illegible]=          45[illegible]        435    FTN4LIB
[illegible]=        45[illegible]        242    FTN4LIB
[illegible]=           45[illegible]        155    FTN4LIB
[illegible]=         45[illegible]         31    FTN4LIB
[illegible]=             46[illegible]         23    FTN4LIB
[illegible]=          46[illegible]         44    FTN4LIB
SINCOS.          47[illegible]14         60    FTN4LIB
[illegible].            47[illegible]74         32    FTN4LIB
[illegible]=         47126          1    FTN4LIB
[illegible]SYS=             47127         14    FTN4LIB
[illegible]SYS=1ST         47143         42    FTN4LIB
T[illegible].             47245         35    FTN4LIB
[illegible]...          47[illegible]          2    FTN4LIB
[illegible]=             47[illegible]5         30    FTN4LIB
[illegible] =             47[illegible]         17    FTN4LIB
[illegible]=             47[illegible]4         66    FTN4LIB
//               47442      11046
T(I)= .[illegible]  .[illegible]  .[illegible]  .51366700  .63605368  .74633191  .83911697  .91223443  .96397193  .9931286.
.(I)= .[illegible]  .[illegible]  .[illegible]  .13168364  .11319453  .10193012  .08327674  .06267205  .04060143  .01761401
      DELTA(I,J)= .[illegible]  .[illegible]  .[illegible]  .00000010  .00000010  .00000010
      DELTA(I,J)= .[illegible]  .[illegible]  .[illegible]  .00000010  .00000010  .00000010
      DELTA(I,J)= .[illegible]  .[illegible]  .[illegible]  .00000010  .00000010  .00000010
      DELTA(I,J)= .[illegible]  .[illegible]  .[illegible]  .00000010  .00000010  .00000010
      DELTA(I,J)= .[illegible]  .[illegible]  .[illegible]  .00000010  .00000010  .00000010
      DELTA(I,J)= .[illegible]  .[illegible]  .[illegible]  .00000010  .00000010  .00000010


                 X AND Y COORDINATES OF UPPER BLADE END POINT=(1.00000, .04050
                 THICKNESS OF PLANO CONVEX FOIL =     0.                XXM=    .70000
                 BETAB AND BETAC AS FIRST GUESS=-180.00000  -180.00000
                 R=  .5[illegible]  AAAA=   .011930  BBBB=  -.060255  CCCC=  -.004140
                 AF=   .133487  BS=  -.454256  CP=   .530844  DP=  -.247618
                 XROUND=   .000097  A2AA=  -.065811  B2BB=   .157909  C2CC=  -.367300
                 AAAAU=   .007073  BBBBU=   .004330  CCCCU=   .[illegible]37202
                 AAU=  -.[illegible]3[illegible]91[illegible]  BBU=   .214535  CSU=  -.186218  CSU=   .051103
                 A2AAU=   .1651[illegible]1  B2BBU=  -.6[illegible]9524  C2CCU=  1. 60982
    LPM=  71  LPK=  3[illegible]  SBETA= 0.                 IREAD=1  NCHBY= 40
       DE=  .1[illegible]E-[illegible]  DS=  .1[illegible]E-02DF=  .1000000E-04  SF4=  .1000000E+02
       SBETA2= -.1[illegible]E+03
       LPM2= 4[illegible]  ISHARP= [illegible].
INCIDENCE ANGLE=  .[illegible]E+[illegible] GAMMA=  .4968000E+02 SOLIDITY=  .5[illegible]52000E+00
    FLAP ANGLE= 0.
       CAVIT. NO =  .5[illegible]E+0[illegible]
       CHORD=  .1[illegible]E+[illegible]1  UPPER SEP. POINT= [illegible].            CONN. POINT(XC,YC)=( 0.              , 0.
 XXCC=  1.[illegible]  YYCC=  .[illegible]40573
       FIDS=  .1[illegible]1761E+[illegible]1
       ITERATION NO.= 2
X(1)=  .1[illegible]E-02
X(2)=  .71[illegible]741[illegible]E-[illegible]1
X(3)=  .[illegible]E-[illegible]1
X(4)=  .33[illegible]79[illegible]E-[illegible]1
X(5)= -.7[illegible]3245[illegible]E-01
X(6)=  .91[illegible]E+0[illegible]
             I=  1   BBTAN2= -.31[illegible]35[illegible]E+01  XKSI=  .7197740E-01
             I=  2   BBTAN2= -.3133767E+01  XKSI=  .7190378E-01
             I=  [illegible]   BBTAN2= -.313414[illegible]E+01  XKSI=  .7195636E-01
```

```
I=  4  BBTAN2= -.3134597E+01  XKSI=  .7203484E-01
I=  5  BBTAN2= -.3135419E+01  XKSI=  .7213672E-01
I=  6  BBTAN2= -.3136235E+01  XKSI=  .7226736E-01
I=  7  BBTAN2= -.3136919E+01  XKSI=  .7241997E-01
I=  8  BBTAN2= -.3137491E+01  XKSI=  .7259561E-01
I=  9  BBTAN2= -.3138064E+01  XKSI=  .7279320E-01
I= 10  BBTAN2= -.3138554E+01  XKSI=  .7301152E-01
I= 11  BBTAN2= -.3139046E+01  XKSI=  .7324922E-01
I= 12  BBTAN2= -.3139512E+01  XKSI=  .7350483E-01
I= 13  BBTAN2= -.3139963E+01  XKSI=  .7377679E-01
I= 14  BBTAN2= -.3140409E+01  XKSI=  .7406341E-01
I= 15  BBTAN2= -.3140834E+01  XKSI=  .7436293E-01
I= 16  BBTAN2= -.3141248E+01  XKSI=  .7467350E-01
I= 17  BBTAN2= -.3141652E+01  XKSI=  .7499321E-01
I= 18  BBTAN2= -.3142043E+01  XKSI=  .7532036E-01
I= 19  BBTAN2= -.3142417E+01  XKSI=  .7565210E-01
I= 20  BBTAN2= -.3142777E+01  XKSI=  .7598722E-01
I= 21  BBTAN2= -.3143123E+01  XKSI=  .7632338E-01
I= 22  BBTAN2= -.3143454E+01  XKSI=  .7665850E-01
I= 23  BBTAN2= -.3143768E+01  XKSI=  .7699052E-01
I= 24  BBTAN2= -.3144063E+01  XKSI=  .7731739E-01
I= 25  BBTAN2= -.3144344E+01  XKSI=  .7763710E-01
I= 26  BBTAN2= -.3144606E+01  XKSI=  .7794767E-01
I= 27  BBTAN2= -.3144851E+01  XKSI=  .7824719E-01
I= 28  BBTAN2= -.3145077E+01  XKSI=  .7853391E-01
I= 29  BBTAN2= -.3145286E+01  XKSI=  .7880577E-01
I= 30  BBTAN2= -.3145478E+01  XKSI=  .7906138E-01
I= 31  BBTAN2= -.3145651E+01  XKSI=  .7929908E-01
I= 32  BBTAN2= -.3145806E+01  XKSI=  .7951740E-01
I= 33  BBTAN2= -.3145944E+01  XKSI=  .7971499E-01
I= 34  BBTAN2= -.3146063E+01  XKSI=  .7989063E-01
I= 35  BBTAN2= -.3146166E+01  XKSI=  .8004324E-01
I= 36  BBTAN2= -.3146250E+01  XKSI=  .8017188E-01
I= 37  BBTAN2= -.3146317E+01  XKSI=  .8027576E-01
I= 38  BBTAN2= -.3146365E+01  XKSI=  .8035424E-01
I= 39  BBTAN2= -.3146402E+01  XKSI=  .8040682E-01
I= 40  BBTAN2= -.3146419E+01  XKSI=  .8043320E-01
XCEND=  .85889E+00    S2=  .14214E+00    YUPPER=  .40352E-01
XCEND=  .85889E+00    S2=  .14214E+00    YUPPER=  .40352E-01
XCEND=  .85889E+00    S2=  .14214E+00    YUPPER=  .40352E-01
XCEND=  .85889E+00    S2=  .14214E+00    YUPPER=  .40352E-01
XCEND=  .85889E+00    S2=  .14214E+00    YUPPER=  .40352E-01
XCEND=  .85889E+00    S2=  .14214E+00    YUPPER=  .40352E-01
XCEND=  .85889E+00    S2=  .14214E+00    YUPPER=  .40352E-01
XCEND=  .85889E+00    S2=  .14214E+00    YUPPER=  .40352E-01
XCEND=  .85889E+00    S2=  .14214E+00    YUPPER=  .40352E-01
XCEND=  .85889E+00    S2=  .14214E+00    YUPPER=  .40352E-01
XCEND=  .85889E+00    S2=  .14214E+00    YUPPER=  .40352E-01
XCEND=  .85889E+00    S2=  .14214E+00    YUPPER=  .40352E-01
XCEND=  .85889E+00    S2=  .14214E+00    YUPPER=  .40352E-01
P(I,J)=  .2539251E+02   -.6896944E+00   .2742325E+00   0.             -.8532453E+00  -.1615823E+00
P(I,J)=  .1553134E+03    .2126690E+01  -.7615647E+00  -.8897170E+01    .5119634E+00  -.5636904E+00
P(I,J)= -.4155335E+02    .1919849E+01  -.6897224E+00  -.1042817E+01    .2497401E+00  -.2749730E+00
P(I,J)= -.7226629E+02    .3897493E+00  -.3386625E+00   .1207028E+02    .9914400E+00  -.1091612E+01
P(I,J)=  .4579417E+02    .5236214E+01  -.1059146E+02   .1369444E+02    .1326221E-01  -.1460216E-01
P(I,J)=  .1472087E+03    .3175167E+01  -.1971079E+01  -.7924601E+01    .7166036E+00  -.7890069E+00
                  BIGS2=   .14214  XCCC=   .85889  YCCC=   .04057
    CAVX=  0.          CAVY=  0.
    CAVX=   .00106     CAVY=   .00195
    CAVX=   .00091     CAVY=   .00251
    CAVX=   .00261     CAVY=   .00477
    CAVX=   .00599     CAVY=   .00759
    CAVX=   .01168     CAVY=   .01096
    CAVX=   .01715     CAVY=   .01469
    CAVX=   .02571     CAVY=   .01937
    CAVX=   .03663     CAVY=   .02441
    CAVX=   .05039     CAVY=   .02999
    CAVX=   .06717     CAVY=   .03507
    CAVX=   .08725     CAVY=   .04260
    CAVX=   .11090     CAVY=   .04946
    CAVX=   .13805     CAVY=   .05651
    CAVX=   .16657     CAVY=   .06360
    CAVX=   .20212     CAVY=   .07051
    CAVX=   .23811     CAVY=   .07707
    CAVX=   .27586     CAVY=   .08310
    CAVX=   .31462     CAVY=   .08844
    CAVX=   .35364     CAVY=   .09302
    CAVX=   .39226     CAVY=   .09677
    CAVX=   .43001     CAVY=   .09969
    CAVX=   .46644     CAVY=   .10181
    CAVX=   .50131     CAVY=   .10317
    CAVX=   .53446     CAVY=   .10382
    CAVX=   .56590     CAVY=   .10384
```

```
          CAVX=    .59556     CAVY=    .10328
          CAVX=    .62351     CAVY=    .10218
          CAVX=    .64981     CAVY=    .10061
          CAVX=    .67455     CAVY=    .09858
          CAVX=    .69733     CAVY=    .09614
          CAVX=    .71976     CAVY=    .09328
          CAVX=    .74035     CAVY=    .09003
          CAVX=    .75973     CAVY=    .08637
          CAVX=    .77613     CAVY=    .08222
          CAVX=    .79515     CAVY=    .07770
          CAVX=    .81122     CAVY=    .07253
          CAVX=    .82614     CAVY=    .06662
          CAVX=    .83973     CAVY=    .05964
          CAVX=    .85125     CAVY=    .05062
          CAVX=    .85559     CAVY=    .04057
F(1)= -.68452546E-03
F(2)= -.22317576E-03
F(3)= [illegible]29E-04
F(4)= -.11346430E-02
F(5)=  .12636325E-02
F(6)= -.21556165E-03
X(1)=  .13231435E-02
X(2)=  .71816235E-01
X(3)=  .80250125E-01
X(4)=  .33446045E-01
X(5)= -.71635565E-01
X(6)=  .91775935E+00
                    ITERATION NO.= 1
X(1)=  .13231435E-02
X(2)=  .71816235E-01
X(3)=  .80250125E-01
X(4)=  .3344[illegible]4E-01
X(5)= -.71635565E-01
X(6)=  .91775935E+00
              I=  1  BBTAN2= -.3133560E+01  XKSI=  .7181947E-01
              I=  2  BBTAN2= -.3133747E+01  XKSI=  .7184539E-01
              I=  3  BBTAN2= -.3134140E+01  XKSI=  .7189706E-01
              I=  4  BBTAN2= -.3134697E+01  XKSI=  .7197419E-01
              I=  5  BBTAN2= -.3135419E+01  XKSI=  .7207625E-01
              I=  6  BBTAN2= -.3136295E+01  XKSI=  .7220267E-01
              I=  7  BBTAN2= -.3136919E+01  XKSI=  .7235263E-01
              I=  8  BBTAN2= -.3137490E+01  XKSI=  .7252523E-01
              I=  9  BBTAN2= -.3138[illegible]64E+01  XKSI=  .7271939E-01
              I= 10  BBTAN2= -.3138554E+01  XKSI=  .7293392E-01
              I= 11  BBTAN2= -.3139146E+01  XKSI=  .7316750E-01
              I= 12  BBTAN2= -.3139512E+01  XKSI=  .7341866E-01
              I= 13  BBTAN2= -.3139963E+01  XKSI=  .7368592E-01
              I= 14  BBTAN2= -.3140498E+01  XKSI=  .7396757E-01
              I= 15  BBTAN2= -.3140834E+01  XKSI=  .7426190E-01
              I= 16  BBTAN2= -.3141249E+01  XKSI=  .7456708E-01
              I= 17  BBTAN2= -.3141652E+01  XKSI=  .7488124E-01
              I= 18  BBTAN2= -.3142043E+01  XKSI=  .7520244E-01
              I= 19  BBTAN2= -.3142417E+01  XKSI=  .7552870E-01
              I= 20  BBTAN2= -.3142777E+01  XKSI=  .7585801E-01
              I= 21  BBTAN2= -.3143123E+01  XKSI=  .7618634E-01
              I= 22  BBTAN2= -.3143454E+01  XKSI=  .7651765E-01
              I= 23  BBTAN2= -.3143759E+01  XKSI=  .7684391E-01
              I= 24  BBTAN2= -.3144063E+01  XKSI=  .7716511E-01
              I= 25  BBTAN2= -.3144344E+01  XKSI=  .7747527E-01
              I= 26  BBTAN2= -.3144606E+01  XKSI=  .7778445E-01
              I= 27  BBTAN2= -.3144851E+01  XKSI=  .7837879E-01
              I= 28  BBTAN2= -.3145077E+01  XKSI=  .7836043E-01
              I= 29  BBTAN2= -.3145289E+01  XKSI=  .7862767E-01
              I= 30  BBTAN2= -.3145479E+01  XKSI=  .7887685E-01
              I= 31  BBTAN2= -.3145651E+01  XKSI=  .7911243E-01
              I= 32  BBTAN2= -.3145806E+01  XKSI=  .7932696E-01
              I= 33  BBTAN2= -.3145944E+01  XKSI=  .7952112E-01
              I= 34  BBTAN2= -.3146063E+01  XKSI=  .7969372E-01
              I= 35  BBTAN2= -.3146166E+01  XKSI=  .7984368E-01
              I= 36  BBTAN2= -.3146250E+01  XKSI=  .7997009E-01
              I= 37  BBTAN2= -.3146317E+01  XKSI=  .8007217E-01
              I= 38  BBTAN2= -.3146364E+01  XKSI=  .8014928E-01
              I= 39  BBTAN2= -.3146432E+01  XKSI=  .8020096E-01
              I= 40  BBTAN2= -.3146419E+01  XKSI=  .8022689E-01
    XCEND=  .85910E+00     S2=  .14193E+03     YUPPER=  .40353E-01
    XCEND=  .85910E+00     S2=  .14193E+03     YUPPER=  .40353E-01
    XCEND=  .85910E+00     S2=  .14193E+03     YUPPER=  .40353E-01
    XCEND=  .85910E+00     S2=  .14193E+03     YUPPER=  .40353E-01
    XCEND=  .85910E+00     S2=  .14193E+03     YUPPER=  .40353E-01
    XCEND=  .85910E+00     S2=  .14193E+03     YUPPER=  .40353E-01
    XCEND=  .85910E+00     S2=  .14193E+03     YUPPER=  .40353E-01
    XCEND=  .85910E+00     S2=  .14193E+03     YUPPER=  .40353E-01
    XCEND=  .85910E+00     S2=  .14193E+03     YUPPER=  .40353E-01
    XCEND=  .85910E+00     S2=  .14193E+03     YUPPER=  .40353E-01
    XCEND=  .85910E+00     S2=  .14193E+03     YUPPER=  .40353E-01
    XCEND=  .85910E+00     S2=  .14193E+03     YUPPER=  .40353E-01
    XCEND=  .85910E+00     S2=  .14193E+03     YUPPER=  .40353E-01
```

```
P(I,J)=  .2642131E+02   -.6356349E+00    .2757979E+00    0.             -.8529348E+00   -.1615669E+00
P(I,J)=  .1534244E+03    .2143715E+01   -.7744611E+00   -.8912556E+01    .5117232E+00   -.5621826E+00
P(I,J)= -.4165350E+02    .1932650E+01   -.6202396E+00   -.1044350E+01    .2493757E+00   -.2739658E+00
P(I,J)= -.7243513E+02    .2974679E+00   -.3445613E+00    .1208924E+02    .9932853E+00   -.1091230E+01
P(I,J)=  .4576756E+02    .5252611E+01   -.1066485E+02    .1373571E+02    .1211292E-01   -.1330738E-01
P(I,J)=  .1472277E+03    .3216839E+01   -.2039455E+01   -.7932831E+01    .7156913E+00   -.7862634E+00
                  SIGS2=     .14193  XCCC=     .85910  YCCC=    .04036
        CAVX=   0.            CAVY=   0.
        CAVX=    .00009       CAVY=    .00085
        CAVX=    .00091       CAVY=    .00252
        CAVX=    .00281       CAVY=    .00479
        CAVX=    .00599       CAVY=    .00760
        CAVX=    .01069       CAVY=    .01097
        CAVX=    .01717       CAVY=    .01469
        CAVX=    .02574       CAVY=    .01939
        CAVX=    .03672       CAVY=    .02442
        CAVX=    .05045       CAVY=    .03070
        CAVX=    .06724       CAVY=    .03609
        CAVX=    .08735       CAVY=    .04261
        CAVX=    .11102       CAVY=    .04947
        CAVX=    .13521       CAVY=    .05653
        CAVX=    .16276       CAVY=    .06361
        CAVX=    .20233       CAVY=    .07052
        CAVX=    .23835       CAVY=    .07707
        CAVX=    .27513       CAVY=    .08309
        CAVX=    .31491       CAVY=    .08842
        CAVX=    .35395       CAVY=    .09298
        CAVX=    .39260       CAVY=    .09672
        CAVX=    .43033       CAVY=    .09963
        CAVX=    .46675       CAVY=    .10173
        CAVX=    .50163       CAVY=    .10308
        CAVX=    .53460       CAVY=    .10372
        CAVX=    .56621       CAVY=    .10373
        CAVX=    .59587       CAVY=    .10315
        CAVX=    .62381       CAVY=    .10205
        CAVX=    .65011       CAVY=    .10046
        CAVX=    .67465       CAVY=    .09843
        CAVX=    .69513       CAVY=    .09597
        CAVX=    .72053       CAVY=    .09311
        CAVX=    .74054       CAVY=    .08995
        CAVX=    .76034       CAVY=    .08613
        CAVX=    .77505       CAVY=    .08206
        CAVX=    .79342       CAVY=    .07749
        CAVX=    .81146       CAVY=    .07232
        CAVX=    .82536       CAVY=    .06541
        CAVX=    .83795       CAVY=    .05943
        CAVX=    .85151       CAVY=    .05061
        CAVX=    .85910       CAVY=    .04036
F(1)=  .219[illegible]E-05
F(2)= -.1553[illegible]75E-05
F(3)= -.1304522E-05
F(4)= -.2022951E-03
F(5)=  .1035732E-03
F(6)= -.4217927E-05
X(1)=  .1323436E-02
X(2)=  .7265[illegible]3E-01
X(3)=  .6121956E-01
X(4)=  .3344[illegible]48E-01
X(5)= -.7169999E-01
X(6)=  .91794[illegible]0E+00
                  ITERATION NO.= 2
X(1)=  .1323436E-02
X(2)=  [illegible]E-01
X(3)=  .6121956E-01
X(4)=  .3344748E-01
X(5)= -.7169999E-01
X(6)=  .9179430E+00
               I=  1   BBTAN2= -.3133589E+01   XKSI=   .7185326E-01
               I=  2   BBTAN2= -.3133757E+01   XKSI=   .7187904E-01
               I=  3   BBTAN2= -.3134140E+01   XKSI=   .7193044E-01
               I=  4   BBTAN2= -.3134697E+01   XKSI=   .7200715E-01
               I=  5   BBTAN2= -.3135419E+01   XKSI=   .7210869E-01
               I=  6   BBTAN2= -.3136295E+01   XKSI=   .7223444E-01
               I=  7   BBTAN2= -.3136919E+01   XKSI=   .7238362E-01
               I=  8   BBTAN2= -.3137499E+01   XKSI=   .7255531E-01
               I=  9   BBTAN2= -.3138064E+01   XKSI=   .7274846E-01
               I= 10   BBTAN2= -.3138554E+01   XKSI=   .7296187E-01
               I= 11   BBTAN2= -.3139046E+01   XKSI=   .7319422E-01
               I= 12   BBTAN2= -.3139512E+01   XKSI=   .7344409E-01
               I= 13   BBTAN2= -.3139963E+01   XKSI=   .7370993E-01
               I= 14   BBTAN2= -.3140403E+01   XKSI=   .7399011E-01
               I= 15   BBTAN2= -.3140334E+01   XKSI=   .7428289E-01
               I= 16   BBTAN2= -.3141246E+01   XKSI=   .7458647E-01
               I= 17   BBTAN2= -.3141653E+01   XKSI=   .7489899E-01
               I= 18   BBTAN2= -.3142043E+01   XKSI=   .7521851E-01
```

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I= 19  BETAN2= -.3142417E+01  XKSI=  .7554306E-01
I= 20  BETAN2= -.3142777E+01  XKSI=  .7587064E-01
I= 21  BETAN2= -.3143123E+01  XKSI=  .7619924E-01
I= 22  BETAN2= -.3143454E+01  XKSI=  .7652683E-01
I= 23  BETAN2= -.3143754E+01  XKSI=  .7685138E-01
I= 24  BETAN2= -.3144063E+01  XKSI=  .7717090E-01
I= 25  BETAN2= -.3144344E+01  XKSI=  .7748341E-01
I= 26  BETAN2= -.3144606E+01  XKSI=  .7778700E-01
I= 27  BETAN2= -.3144851E+01  XKSI=  .7807978E-01
I= 28  BETAN2= -.3145077E+01  XKSI=  .7835996E-01
I= 29  BETAN2= -.3145286E+01  XKSI=  .7862580E-01
I= 30  BETAN2= -.3145478E+01  XKSI=  .7887567E-01
I= 31  BETAN2= -.3145651E+01  XKSI=  .7910602E-01
I= 32  BETAN2= -.3145806E+01  XKSI=  .7932143E-01
I= 33  BETAN2= -.3145944E+01  XKSI=  .7951457E-01
I= 34  BETAN2= -.3146067E+01  XKSI=  .7968626E-01
I= 35  BETAN2= -.3146156E+01  XKSI=  .7983544E-01
I= 36  BETAN2= -.3146259E+01  XKSI=  .7996119E-01
I= 37  BETAN2= -.3146317E+01  XKSI=  .8006273E-01
I= 38  BETAN2= -.3146369E+01  XKSI=  .8013944E-01
I= 39  BETAN2= -.3146402E+01  XKSI=  .8019065E-01
I= 40  BETAN2= -.3146419E+01  XKSI=  .8021663E-01
XCENO=  .65935E+00     S2=  .14168E+00     YUPPER=  .40355E-01
XCENO=  .65935E+00     S2=  .14168E+00     YUPPER=  .40355E-01
XCENO=  .65935E+00     S2=  .14168E+00     YUPPER=  .40355E-01
XCENO=  .65935E+00     S2=  .14168E+00     YUPPER=  .40355E-01
XCENO=  .65935E+00     S2=  .14168E+00     YUPPER=  .40355E-01
XCENO=  .65935E+00     S2=  .14168E+00     YUPPER=  .40355E-01
XCENO=  .65935E+00     S2=  .14168E+00     YUPPER=  .40355E-01
XCENO=  .65935E+00     S2=  .14168E+00     YUPPER=  .40355E-01
XCENO=  .65935E+00     S2=  .14168E+00     YUPPER=  .40355E-01
XCENO=  .65935E+00     S2=  .14168E+00     YUPPER=  .40355E-01
XCENO=  .65935E+00     S2=  .14168E+00     YUPPER=  .40355E-01
XCENO=  .65935E+00     S2=  .14168E+00     YUPPER=  .40355E-01
XCENO=  .65935E+00     S2=  .14168E+00     YUPPER=  .40355E-01
P(I,J)=  .2542661E+02  -.6973926E+00   .2799757E+00   0.             -.8528401E+00  -.1616584E+00
P(I,J)=  .1553334E+03   .2147697E+01  -.7782136E+00  -.6914212E+01    .5113321E+00  -.5617097E+00
P(I,J)= -.4167569E+02   .1534579E+01  -.6231763E+00  -.1042636E+01    .2490537E+00  -.2735910E+00
P(I,J)= -.7044943E+02   .4995373E+00  -.3463079E+00   .1209359E+02    .9933269E+00  -.1091192E+01
P(I,J)=  .4573568E+02   .5263451E+01  -.1067957E+02   .1374004E+02    .1174417E-01  -.1290137E-01
P(I,J)=  .1471753E+03   .3229123E+01  -.2021122E+01  -.7934385E+01    .7150947E+00  -.7855474E+00
            SIGS2=    .14168  XCCC=    .65935  YCCC=    .04035
      CAVX=   0.          CAVY=   0.
      CAVX=   .00[illegible]      CAVY=   .00[illegible]85
      CAVX=   .00091      CAVY=   .00252
      CAVX=   .00281      CAVY=   .00479
      CAVX=   .00603      CAVY=   .00760
      CAVX=   .01177      CAVY=   .01098
      CAVX=   .01719      CAVY=   .01490
      CAVX=   .02577      CAVY=   .01939
      CAVX=   .03577      CAVY=   .02444
      CAVX=   .05151      CAVY=   .03003
      CAVX=   .06773      CAVY=   .03612
      CAVX=   .08749      CAVY=   .04265
      CAVX=   .11117      CAVY=   .04952
      CAVX=   .13338      CAVY=   .05659
      CAVX=   .16497      CAVY=   .06366
      CAVX=   .20256      CAVY=   .07058
      CAVX=   .23563      CAVY=   .07713
      CAVX=   .27544      CAVY=   .08314
      CAVX=   .31524      CAVY=   .08846
      CAVX=   .35423      CAVY=   .09303
      CAVX=   .39495      CAVY=   .09676
      CAVX=   .43069      CAVY=   .09967
      CAVX=   .46712      CAVY=   .10177
      CAVX=   .50203      CAVY=   .10311
      CAVX=   .53516      CAVY=   .10375
      CAVX=   .56637      CAVY=   .10375
      CAVX=   .59521      CAVY=   .10317
      CAVX=   .62415      CAVY=   .10206
      CAVX=   .65044      CAVY=   .10047
      CAVX=   .67517      CAVY=   .09843
      CAVX=   .69544      CAVY=   .09597
      CAVX=   .72034      CAVY=   .09311
      CAVX=   .74094      CAVY=   .08985
      CAVX=   .76033      CAVY=   .08618
      CAVX=   .77856      CAVY=   .08207
      CAVX=   .79569      CAVY=   .07748
      CAVX=   .81173      CAVY=   .07232
      CAVX=   .82603      CAVY=   .06640
      CAVX=   .84727      CAVY=   .05942
      CAVX=   .85176      CAVY=   .05060
      CAVX=   .85935      CAVY=   .04036
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```
F(1)=  .4644316E-07
F(2)= -.1337475E-06
F(3)= -.6525717E-07
F(4)= -.7135016E-04
F(5)=  .1157357E-03
F(6)= -.3365667E-06
X(1)=  .1323576E-02
X(2)=  .7156433E-01
X(3)=  .8021794E-01
X(4)=  .3344155E-01
X(5)= -.7197974E-01
X(6)=  .9130321E+00
          SXSI(.1)=  .1323573E-02
          SXSI(.2)=  .7156433E-01
          SXSI(.3)=  .8021794E-01
          SXSI(.4)=  .3344135E-01
          SXSI(.5)= -.7197974E-01
          SXSI(.6)=  .9130321E+00
I= 71 SARC= 0.             XXX= 0.             CP= -.5000000E+00 BETAN= -.6571643E-01
I= 70 SARC=  .5727181E-03 XXX=  .5714678E-03 CP=  .9790812E+00 BETAN= -.6553708E-01
I= 69 SARC=  .1499761E-02 XXX=  .1496550E-02 CP=  .9962424E+00 BETAN= -.6524828E-01
I= 68 SARC=  .2574631E-02 XXX=  .2568933E-02 CP=  .9681730E+00 BETAN= -.6488494E-01
I= 67 SARC=  .4054578E-02 XXX=  .4045959E-02 CP=  .9333438E+00 BETAN= -.6446200E-01
I= 66 SARC=  .5612234E-02 XXX=  .5598450E-02 CP=  .8992332E+00 BETAN= -.6399016E-01
I= 65 SARC=  .7319151E-02 XXX=  .7303980E-02 CP=  .8675770E+00 BETAN= -.6347788E-01
I= 64 SARC=  .9152996E-02 XXX=  .9144067E-02 CP=  .8356978E+00 BETAN= -.6293226E-01
I= 63 [redacted]  .1112635E-01 XXX=  .1110357E-01 CP=  .8124407E+00 BETAN= -.6235939E-01
I= 62 SARC=  .1319591E-01 XXX=  .1316914E-01 CP=  .7935693E+00 BETAN= -.6176459E-01
I= 61 SARC=  .1536009E-01 XXX=  .1532923E-01 CP=  .7658824E+00 BETAN= -.6115254E-01
I= 60 SARC=  .1760664E-01 XXX=  .1757363E-01 CP=  .7459054E+00 BETAN= -.6052741E-01
I= 59 SARC=  .1993253E-01 XXX=  .1989331E-01 CP=  .7236519E+00 BETAN= -.5989269E-01
I= 58 SARC=  .2232363E-01 XXX=  .2228017E-01 CP=  .7118591E+00 BETAN= -.5925228E-01
I= 57 SARC=  .2477468E-01 XXX=  .2472697E-01 CP=  .6963594E+00 BETAN= -.5860851E-01
I= 56 SARC=  .2727916E-01 XXX=  .2722719E-01 CP=  .6820174E+00 BETAN= -.5796422E-01
I= 55 SARC=  .2983116E-01 XXX=  .2977496E-01 CP=  .6687790E+00 BETAN= -.5732176E-01
I= 54 SARC=  .3242536E-01 XXX=  .3236495E-01 CP=  .6563332E+00 BETAN= -.5668322E-01
I= 53 SARC=  .3505693E-01 XXX=  .3499234E-01 CP=  .6447970E+00 BETAN= -.5605046E-01
I= 52 SARC=  .3772148E-01 XXX=  .3765276E-01 CP=  .6340239E+00 BETAN= -.5542516E-01
I= 51 SARC=  .4041504E-01 XXX=  .4134223E-01 CP=  .6239429E+00 BETAN= -.5480880E-01
I= 50 SARC=  .4313399E-01 XXX=  .4305714E-01 CP=  .6144950E+00 BETAN= -.5420266E-01
I= 49 SARC=  .4567590E-01 XXX=  .4579417E-01 CP=  .6056250E+00 BETAN= -.5360798E-01
I= 48 SARC=  .4863509E-01 XXX=  .4855034E-01 CP=  .5972866E+00 BETAN= -.5302571E-01
I= 47 SARC=  .5141150E-01 XXX=  .5132239E-01 CP=  .5894362E+00 BETAN= -.5245680E-01
I= 46 SARC=  .5420171E-01 XXX=  .5410930E-01 CP=  .5820369E+00 BETAN= -.5190203E-01
I= 45 SARC=  .5700344E-01 XXX=  .5690730E-01 CP=  .5750536E+00 BETAN= -.5136209E-01
I= 44 SARC=  .5981458E-01 XXX=  .5971479E-01 CP=  .5684566E+00 BETAN= -.5083759E-01
I= 43 SARC=  .6263322E-01 XXX=  .6252981E-01 CP=  .5622173E+00 BETAN= -.5032904E-01
I= 42 SARC=  .6545760E-01 XXX=  .6535065E-01 CP=  .5563113E+00 BETAN= -.4983690E-01
I= 41 SARC=  .6828611E-01 XXX=  .6817568E-01 CP=  .5507150E+00 BETAN= -.4936153E-01
I= 40 SARC=  .7111727E-01 XXX=  .7100343E-01 CP=  .5454083E+00 BETAN= -.4890325E-01
I= 39 SARC=  .7394974E-01 XXX=  .7383254E-01 CP=  .5403715E+00 BETAN= -.4846233E-01
I= 38 SARC=  .7678227E-01 XXX=  .7666178E-01 CP=  .5355874E+00 BETAN= -.4803596E-01
I= 37 SARC=  .7961374E-01 XXX=  .7949000E-01 CP=  .5310402E+00 BETAN= -.4763332E-01
I= 36 SARC=  .8244310E-01 XXX=  .8231618E-01 CP=  .5267150E+00 BETAN= -.4724553E-01
I= 35 SARC=  .8526940E-01 XXX=  .8513933E-01 CP=  .5225983E+00 BETAN= -.4687567E-01
I= 34 SARC=  .8809177E-01 XXX=  .8795564E-01 CP=  .5186766E+00 BETAN= -.4652380E-01
I= 33 SARC=  .9090940E-01 XXX=  .9077325E-01 CP=  .5149397E+00 BETAN= -.4618994E-01
I= 32 SARC=  .9372157E-01 XXX=  .9358244E-01 CP=  .5113760E+00 BETAN= -.4587406E-01
I= 31 SARC=  .9652769E-01 XXX=  .9638554E-01 CP=  .5079755E+00 BETAN= -.4557620E-01
I= 30 SARC=  .9932654E-01 XXX=  .9918189E-01 CP=  .5046885E+00 BETAN= -.4529624E-01
I= 29 SARC=  .2047693E+00 XXX=  .2045226E+00 CP=  .4341331E+00 BETAN= -.4682966E-01
I= 28 SARC=  .2909101E+00 XXX=  .2905059E+00 CP=  .4096958E+00 BETAN= -.5015210E-01
I= 27 SARC=  .3617993E+00 XXX=  .3614484E+00 CP=  .3968519E+00 BETAN= -.5354716E-01
I= 26 SARC=  .4218360E+00 XXX=  .4214472E+00 CP=  .3891902E+00 BETAN= -.5671953E-01
I= 25 SARC=  .4737292E+00 XXX=  .4733022E+00 CP=  .3839676E+00 BETAN= -.5962840E-01
I= 24 SARC=  .5193622E+00 XXX=  .5189044E+00 CP=  .3801824E+00 BETAN= -.6229032E-01
I= 23 SARC=  .5600604E+00 XXX=  .5595734E+00 CP=  .3772525E+00 BETAN= -.6473385E-01
I= 22 SARC=  .5967707E+00 XXX=  .5962567E+00 CP=  .3749057E+00 BETAN= -.6698714E-01
I= 21 SARC=  .6301966E+00 XXX=  .6296574E+00 CP=  .3729680E+00 BETAN= -.6907514E-01
I= 20 SARC=  .6608719E+00 XXX=  .6603099E+00 CP=  .3713497E+00 BETAN= -.7101898E-01
I= 19 SARC=  .6892123E+00 XXX=  .6886268E+00 CP=  .3699955E+00 BETAN= -.7283652E-01
I= 18 SARC=  .7155462E+00 XXX=  .7149393E+00 CP=  .3688844E+00 BETAN= -.7454270E-01
I= 17 SARC=  .7401395E+00 XXX=  .7395122E+00 CP=  .3680244E+00 BETAN= -.7615020E-01
I= 16 SARC=  .7632093E+00 XXX=  .7625624E+00 CP=  .3674592E+00 BETAN= -.7766980E-01
I= 15 SARC=  .7849377E+00 XXX=  .7842720E+00 CP=  .3673949E+00 BETAN= -.7911082E-01
I= 14 SARC=  .8054814E+00 XXX=  .8047957E+00 CP=  .3681574E+00 BETAN= -.8079078E-01
I= 13 SARC=  .8249744E+00 XXX=  .8242129E+00 CP=  .3690764E+00 BETAN= -.8364473E-01
I= 12 SARC=  .8435136E+00 XXX=  .8426349E+00 CP=  .3693959E+00 BETAN= -.8668276E-01
I= 11 SARC=  .8611813E+00 XXX=  .8602831E+00 CP=  .3692383E+00 BETAN= -.9043366E-01
I= 10 SARC=  .8775496E+00 XXX=  .8770796E+00 CP=  .3625664E+00 BETAN= -.9424602E-01
I=  9 SARC=  .8941[illegible]E+00 XXX=  .8931354E+00 CP=  .3673532E+00 BETAN= -.9827576E-01
I=  8 SARC=  .9096263E+00 XXX=  .9085040E+00 CP=  .3654655E+00 BETAN= -.1024650E+00
```

```
I=  7 SARC=  .9244346E+00 XXX=  .9232313E+00 CP=  .3629195E+00 BETAN= -.1066406E+00
I=  6 SARC=  .9756452E+00 XXX=  .9373579E+00 CP=  .3594371E+00 BETAN= -.1113140E+00
I=  5 SARC=  .9822923E+00 XXX=  .9509166E+00 CP=  .3551353E+00 BETAN= -.1158786E+00
I=  4 SARC=  .9654046E+00 XXX=  .9633375E+00 CP=  .3494019E+00 BETAN= -.1205109E+00
I=  3 SARC=  .9733095E+00 XXX=  .9764469E+00 CP=  .3446695E+00 BETAN= -.1251897E+00
I=  2 SARC=  .9971156E+00 XXX=  .9854561E+00 CP=  .3330276E+00 BETAN= -.1298915E+00
I=  1 SARC=  .1031690E+01 XXX=  .9999286E+00 CP=  .2973646E+00 BETAN= -.1345742E+00
      I=  1 SARC2= 0.                XXX2=  .9593486E+00 CP2= -.5000000E+00 BETAN2= -.3133894E+01
      I=  2 SARC2=  .1421535E-01 XXX2=  .8735663E+00 CP2=  .9686379E+00 BETAN2= -.3135412E+01
      I=  3 SARC2=  .2843616E-01 XXX2=  .8877842E+00 CP2=  .9536373E+00 BETAN2= -.3136868E+01
      I=  4 SARC2=  .3527441E-01 XXX2=  .8946224E+00 CP2=  .9131505E+00 BETAN2= -.3137546E+01
      I=  5 SARC2=  .4211267E-01 XXX2=  .9014606E+00 CP2=  .8739149E+00 BETAN2= -.3138210E+01
      I=  6 SARC2=  .4693340E-01 XXX2=  .9062863E+00 CP2=  .8375476E+00 BETAN2= -.3138669E+01
      I=  7 SARC2=  .5176413E-01 XXX2=  .9111120E+00 CP2=  .8042569E+00 BETAN2= -.3139122E+01
      I=  8 SARC2=  .5579379E-01 XXX2=  .9151417E+00 CP2=  .7736480E+00 BETAN2= -.3139495E+01
      I=  9 SARC2=  .5982344E-01 XXX2=  .9191713E+00 CP2=  .7461198E+00 BETAN2= -.3139862E+01
      I= 10 SARC2=  .6340591E-01 XXX2=  .9227538E+00 CP2=  .7204749E+00 BETAN2= -.3140155E+01
      I= 11 SARC2=  .6698635E-01 XXX2=  .9263362E+00 CP2=  .6965324E+00 BETAN2= -.3140504E+01
      I= 12 SARC2=  .7027501E-01 XXX2=  .9296239E+00 CP2=  .6751436E+00 BETAN2= -.3140792E+01
      I= 13 SARC2=  .7356364E-01 XXX2=  .9329115E+00 CP2=  .6549034E+00 BETAN2= -.3141078E+01
      I= 14 SARC2=  .7663766E-01 XXX2=  .9359855E+00 CP2=  .6361365E+00 BETAN2= -.3141342E+01
      I= 15 SARC2=  .7971168E-01 XXX2=  .9390595E+00 CP2=  .6187795E+00 BETAN2= -.3141603E+01
      I= 16 SARC2=  .8262597E-01 XXX2=  .9419686E+00 CP2=  .6018006E+00 BETAN2= -.3141848E+01
      I= 17 SARC2=  .8553027E-01 XXX2=  .9448781E+00 CP2=  .5861688E+00 BETAN2= -.3142090E+01
      I= 18 SARC2=  .8830675E-01 XXX2=  .9476546E+00 CP2=  .5714329E+00 BETAN2= -.3142318E+01
      I= 19 SARC2=  .9105323E-01 XXX2=  .9504311E+00 CP2=  .5574493E+00 BETAN2= -.3142545E+01
      I= 20 SARC2=  .9374694E-01 XXX2=  .9530966E+00 CP2=  .5441630E+00 BETAN2= -.3142759E+01
      I= 21 SARC2=  .9641465E-01 XXX2=  .9557625E+00 CP2=  .5314963E+00 BETAN2= -.3142972E+01
      I= 22 SARC2=  .9899550E-01 XXX2=  .9583333E+00 CP2=  .5193996E+00 BETAN2= -.3143175E+01
      I= 23 SARC2=  .1015563E+00 XXX2=  .9609042E+00 CP2=  .5077887E+00 BETAN2= -.3143376E+01
      I= 24 SARC2=  .1040442E+00 XXX2=  .9633920E+00 CP2=  .4966341E+00 BETAN2= -.3143569E+01
      I= 25 SARC2=  .1065320E+00 XXX2=  .9658799E+00 CP2=  .4858608E+00 BETAN2= -.3143750E+01
      I= 26 SARC2=  .1089459E+00 XXX2=  .9682937E+00 CP2=  .4754665E+00 BETAN2= -.3143943E+01
      I= 27 SARC2=  .1113597E+00 XXX2=  .9707075E+00 CP2=  .4654002E+00 BETAN2= -.3144124E+01
      I= 28 SARC2=  .1137065E+00 XXX2=  .9730543E+00 CP2=  .4555838E+00 BETAN2= -.3144299E+01
      I= 29 SARC2=  .1160533E+00 XXX2=  .9754012E+00 CP2=  .4459948E+00 BETAN2= -.3144472E+01
      I= 30 SARC2=  .1183385E+00 XXX2=  .9776863E+00 CP2=  .4365848E+00 BETAN2= -.3144639E+01
      I= 31 SARC2=  .1206237E+00 XXX2=  .9799715E+00 CP2=  .4273105E+00 BETAN2= -.3144804E+01
      I= 32 SARC2=  .1228512E+00 XXX2=  .9821990E+00 CP2=  .4181231E+00 BETAN2= -.3144964E+01
      I= 33 SARC2=  .1250788E+00 XXX2=  .9844266E+00 CP2=  .4089579E+00 BETAN2= -.3145122E+01
      I= 34 SARC2=  .1272516E+00 XXX2=  .9865994E+00 CP2=  .3997447E+00 BETAN2= -.3145274E+01
      I= 35 SARC2=  .1294244E+00 XXX2=  .9887722E+00 CP2=  .3903921E+00 BETAN2= -.3145425E+01
      I= 36 SARC2=  .1315439E+00 XXX2=  .9908916E+00 CP2=  .3807741E+00 BETAN2= -.3145572E+01
      I= 37 SARC2=  .1336634E+00 XXX2=  .9930111E+00 CP2=  .3707023E+00 BETAN2= -.3145716E+01
      I= 38 SARC2=  .1357057E+00 XXX2=  .9950763E+00 CP2=  .3596658E+00 BETAN2= -.3145856E+01
      I= 39 SARC2=  .1377939E+00 XXX2=  .9971416E+00 CP2=  .3476594E+00 BETAN2= -.3145994E+01
      I= 40 SARC2=  .1397938E+00 XXX2=  .9991414E+00 CP2=  .3325091E+00 BETAN2= -.3146127E+01
      I= 41 SARC2=  .1417936E+00 XXX2=  .1001141E+01 CP2=  .2973646E+00 BETAN2= -.3146259E+01
CLINF OR CDINF=FORCE/1/2RO*UINF**2      CLINF=  .9645028E+00 CDINF=  .2017576E-01
FINF IS OBTAINED FROM MOMENTUM EQNFINF=  .1105638E+01
---CDLL & CDDD ARE BASED ON U1 IN ALFA1 DIRE.---
CDDD=  [illegible]  CDLL=  [illegible]  L/D=  .6405365E+01
 ---CAVITY SHAPE-----
         X= 0.                    Y= 0.
         X=  [illegible]          Y=  .8492576E-03
         X=  [illegible]          Y=  .2317521E-02
         X=  [illegible]          Y=  .4781095E-02
         X=  [illegible]          Y=  .7502726E-02
         X=  [illegible]          Y=  .1097690E-01
         X=  [illegible]          Y=  .1490487E-01
         X=  .2577275E-01         Y=  .1939394E-01
         X=  [illegible]          Y=  .2444114E-01
         X=  .5051277E-01         Y=  .3003030E-01
         X=  .6733285E-01         Y=  .3612346E-01
         X=  .8749133E-01         Y=  .4265342E-01
         X=  .1111659E+00         Y=  .4951793E-01
         X=  .1333639E+00         Y=  .5657795E-01
         X=  .1659743E+00         Y=  .6366164E-01
         X=  .2025774E+00         Y=  .7057717E-01
         X=  .2386309E+00         Y=  .7712982E-01
         X=  .2764372E+00         Y=  .8314294E-01
         X=  .3152376E+00         Y=  .8847539E-01
         X=  .3542933E+00         Y=  .9303189E-01
         X=  .3929527E+00         Y=  .9676462E-01
         X=  .4306913E+00         Y=  .9946745E-01
         X=  .4671236E+00         Y=  .1017661E+00
         X=  [illegible]          Y=  .1031069E+00
         X=  .5331632E+00         Y=  .1037473E+00
         X=  .5653601E+00         Y=  .1037480E+00
         X=  .5952142E+00         Y=  .1031673E+00
         X=  .6241472E+00         Y=  .1020563E+00
         X=  [illegible]          Y=  .1004663E+00
```

X=	.6751732E+00	Y=	.9342753E-01
X=	.6984426E+00	Y=	.9396389E-01
X=	.7203366E+00	Y=	.9310682E-01
X=	.7403939E+00	Y=	.8984603E-01
X=	.7603282E+00	Y=	.8517747E-01
X=	.7795646E+00	Y=	.8207432E-01
X=	.7956931E+00	Y=	.7748441E-01
X=	.8117278E+00	Y=	.7231529E-01
X=	.8264257E+00	Y=	.6640119E-01
X=	.8402039E+00	Y=	.5941926E-01
X=	.8517606E+00	Y=	.5059937E-01
X=	.8593496E+00	Y=	.4035566E-01

----------UPPER RUBY SHAPE----------

X=	0.	Y=	0.
X=	.02000	Y=	.00346
X=	.04000	Y=	.00548
X=	.06000	Y=	.00824
X=	.08000	Y=	.01124
X=	.10000	Y=	.01371
X=	.12000	Y=	.01494
X=	.14000	Y=	.0161
X=	.16000	Y=	.01750
X=	.18000	Y=	.01867
X=	.20000	Y=	.01994
X=	.22000	Y=	.02105
X=	.24000	Y=	.02211
X=	.26000	Y=	.02313
X=	.28000	Y=	.02411
X=	.30000	Y=	.02505
X=	.32000	Y=	.02596
X=	.34000	Y=	.02694
X=	.36000	Y=	.02758
X=	.38000	Y=	.02849
X=	.40000	Y=	.02926
X=	.42000	Y=	.03003
X=	.44000	Y=	.03075
X=	.46000	Y=	.03146
X=	.48000	Y=	.03217
X=	.50000	Y=	.03279
X=	.52000	Y=	.03341
X=	.54000	Y=	.03401
X=	.56000	Y=	.03458
X=	.58000	Y=	.03513
X=	.60000	Y=	.03566
X=	.62000	Y=	.03618
X=	.64000	Y=	.03665
X=	.66000	Y=	.03712
X=	.68000	Y=	.03754
X=	.70000	Y=	.03796
X=	.72000	Y=	.03835
X=	.74000	Y=	.03872
X=	.76000	Y=	.03906
X=	.78000	Y=	.03939
X=	.80000	Y=	.03970
X=	.82000	Y=	.03996
X=	.84000	Y=	.04019
X=	.86000	Y=	.04036
X=	.88000	Y=	.04049
X=	.90000	Y=	.04058
X=	.92000	Y=	.04063
X=	.94000	Y=	.04065
X=	.96000	Y=	.04063
X=	.98000	Y=	.04058
X=	1.00000	Y=	.04050

.1323585E-02	.7186435E-01	.9021799E-01	.3344155E-01	-.7190975E-01	.9133002E+00
.1091690E+01	-.1345742E+00				
.3901166E+01	-.1290315E+00				
.3750090E+01	-.1251497E+00				
.3654064E+01	-.1205139E+00				
.3522523E+01	-.1153756E+00				
.3364452E+01	-.1113140E+00				
.3244349E+01	-.1064540E+00				
.3036261E+01	-.1024659E+00				
.3941600E+01	-.9627576E-01				
.3794496E+01	-.9424032E-01				
.3611815E+01	-.9043366E-01				
.5435150E+01	-.8605276E-01				
.5245744E+01	-.8364473E-01				
.5054614E+01	-.8176174E-01				
.7944377E+01	-.7911522E-01				
.7534093E+01	-.7763965E-01				
.7401399E+01	-.7615120E-01				
.7135462E+01	-.7454270E-01				
.6692123E+01	-.7253652E-01				
.6303719E+01	-.7101399E-01				
.6301935E+01	-.5997514E-01				
.5957777E+01	-.5609714E-01				
.5500640E+01	-.5475165E-01				
.5193620E+01	-.5229072E-01				
.4717262E+01	-.5992640E-01				
.4215360E+01	-.5671953E-01				
.4517995E+01	-.5354716E-01				
.3901510E+01	-.5015210E-01				
.2047695E+01	-.4461276E-01				
.3953654E-01	-.4529614E-01				
.3652760E-01	-.4557621E-01				
.3772157E-01	-.4527403E-01				
.3030540E-01	-.4515994E-01				
.3609177E-01	-.4652039E-01				
.3516940E-01	-.4467597E-01				
.3244310E-01	-.4724553E-01				
.7951776E-01	-.4753332E-01				
.7675227E-01	-.4503839E-01				
.7344974E-01	-.4346233E-01				
.7111707E-01	-.4469032E-01				
.6005011E-01	-.4936033E-01				
.6545740E-01	-.4947550E-01				
.6233220E-01	-.5032404E-01				
.5961450E-01	-.5060759E-01				
.5770344E-01	-.5136009E-01				
.5400171E-01	-.5150103E-01				
.5104115E-01	-.5245660E-01				
.4463571E-01	-.5302671E-01				
.4507030E-01	-.5360793E-01				
.4713390E-01	-.5421044E-01				
.4041530E-01	-.5440350E-01				
.3772140E-01	-.5564261E-01				
.3595450E-01	-.5591540E-01				
.3442500E-01	-.5660120E-01				
.2451114E-01	-.5732176E-01				
.2707915E-01	-.5796422E-01				
.2477450E-01	-.5961251E-01				
.2222367E-01	-.5925423E-01				
.1993203E-01	-.5999133E-01				
.1750664E-01	-.6150741E-01				
.1579010E-01	-.6115054E-01				
.1319591E-01	-.6176459E-01				
.1112615E-01	-.6235319E-01				
.9066995E-02	-.6293223E-01				
.7319151E-02	-.6367795E-01				
.5611234E-02	-.6397016E-01				
.4039571E-02	-.6444603E-01				
.2679651E-02	-.6460494E-01				
.1499761E-02	-.6524623E-01				
.5727131E-03	-.6553703E-01				
0.	-.6571643E-01				
0.	-.3113396E+00				
.1421839E-01	-.3125412E+00				
.2843616E-01	-.3136665E+00				
.3527441E-01	-.3137946E+00				
.4211267E-01	-.3132211E+00				
.4653900E-01	-.3136694E+00				
.5176411E-01	-.3139122E+00				
.5573379E-01	-.3139935E+00				
.5962344E-01	-.3139425E+00				
.5345591E-01	-.3140145E+00				
.5536417E-01	-.3140530E+00				

.70276015E-01	-.31407792E+01
.733[illegible]3[illegible]4E-01	-.31411079E+01
.7663[illegible][illegible][illegible]E-01	-.31413428E+01
.79711[illegible][illegible]E-01	-.31416031E+01
.8262097E-01	-.3141848E+01
.8553027E-01	-.3142090E+01
.88[illegible]3[illegible]07E-01	-.31423158E+01
.91[illegible]33[illegible]E-01	-.31425455E+01
.9374[illegible][illegible]4E-01	-.31427598E+01
.9641466E-01	-.31429728E+01
.989[illegible]5[illegible]E-01	-.31431758E+01
.10155[illegible]3E+00	-.3143378[illegible]E+01
.1040[illegible]442E+00	-.31435698E+01
.1065327E+00	-.31437600E+01
.1089[illegible]58E+00	-.31439438E+01
.111359[illegible]E+00	-.31441248E+01
.1137[illegible][illegible]8E+00	-.31442998E+01
.1160533E+00	-.31444728E+01
.1183356E+00	-.31446398E+01
.120[illegible][illegible]227E+00	-.3144[illegible]04E+01
.1228511E+00	-.31449648E+01
.1250[illegible]7[illegible]E+00	-.31451202E+01
.127251[illegible]E+00	-.31452748E+01
.1294[illegible]44E+00	-.31454258E+01
.13164[illegible][illegible]E+00	-.31455728E+01
.1336[illegible][illegible]4E+00	-.3145719[illegible]E+01
.13572[illegible]7E+00	-.3145856[illegible]E+01
.13779[illegible]9E+00	-.3145[illegible][illegible]94E+01
.13[illegible]793[illegible]E+00	-.31461278E+01
.14179[illegible][illegible]E+00	-.314[illegible][illegible][illegible]9E+01

5.0 LISTING OF PCASE

```
      PROGRAM PCASE(INPUT,OUPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE7,TAPE1)
C  NONLINEAR PARTIALLY CAVITATING CASCADE CALCULATIONS.
C  5/17/1978 PROGRAMMED BY J. FURUYA.
      DIMENSION YBE(5),XZ(5),BETAND(513),BETAMD(513),BETAD2(100)
      DIMENSION SXSI(6),XXX(513),CP(513),INT(10),XCP(5),YCP(5)
      DIMENSION FL(200),FD(200),CP2(101),XXX2(201),FL2(100),FD2(100)
      COMMON/FOILEND/XXDD,YYDD
      COMMON/UPPER/A2AAJ,B2BBJ,C2CCJ,AAAAJ,BBBBJ,CCCCJ,A8J,B8J,C8U,D8U
      COMMON/FREECAV/XFREEC,YFREEC
      COMMON/DELTAD/DELT(6,6)
      COMMON YCCC,SBETA2
      COMMON XITN(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCMBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFA1,SAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOD(513)
      COMMON IOJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(6),SXSIOD(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
C BETAN-----FOR ARC 1  FOR REGULAR INTEGRAL.
C BBTAN IS FOR INTERPOLATED VERSION OF BETAN .
C BETAN2 FOR EQUALLY SPACED INCREMENT FOR ARC 2.
C BBTAN2 FOR CHEBYCHEV- GAUSS VERSION OF BETAN2.
C                                                        HT/KCIHT/NOMMOC
C                                                  ECAPSE )095,5( DAER
C                                                 ECAPSE )0885,6( ETIRW
C                        )4,3F,*-----SNICAPS LEDOM EKAW NEPO------*,X01( TAMROF 0885
      PAI=3.141592653
      READ(5,795) NGAUS
      NGAUS1=NGAUS+1
      NNN2=NGAUS/2
      NGAUS2=NNN2+1
      READ(5,560) (TGAUS(I),I=NGAUS2,NGAUS)
      READ(5,560) (WGAUS(I),I=NGAUS2,NGAUS)
      DO 26 IQ=1,NNN2
      TGAUS(IQ)=-TGAUS(NGAUS1-IQ)
   26 WGAUS(IQ)=WGAUS(NGAUS1-IQ)
      WRITE(6,561) (TGAUS(I),I=NGAUS2,NGAUS)
      WRITE(6,562) (WGAUS(I),I=NGAUS2,NGAUS)
  560 FORMAT(4F20.10)
  561 FORMAT(1X,*T(I)=*,10(F10.8,1X))
      READ (5,590) XXM

      DO 589 IDELTA=1,6
  589 READ (5,590) (DELT(I)DELTA,I),I=1,6)
  562 FORMAT(1X,*W(I)=*,10(F10.8,1X))


      READ(5,560) TH,XXDD,YYDD                                          C
      READ(5,560) R,AAAA,BBBB,CCCC
      READ(5,560) A8,B8,C8,D8
      READ(5,560) XROUND,A2AA,B2BB,C2CC
      READ(5,560) AAAAJ,BBBBJ,CCCCJ
      READ (5,560) A8U,B8J,C8U,D8J
      READ (5,560) A2AAJ,B2BBJ,C2CCJ
      READ(5,795) IFLAG1 ,NCMBY
```

```
      READ(5,1321) SBETA ,SBETA2,SF4,BETA3,BETAC
      READ(5,551) LPMS,LPKS,LPM2,IFLAG,IREAD,ISHARP
      READ(5,201) NITER,MSTOP,MAXIT,NHK
      READ(5,202) A_FAIS,BAMMAS,SOLIS,   SIGMS
      READ(5,229) DE,DG,DF
      DO 592 IDELTA=1,6
  592 WRITE (6,591) (DELT(IDELTA,I),I=1,6)
      WRITE(6,6553)
 6553 FORMAT(1H1)


      YYDD=A8U+B8U+C8U+D8J
      WRITE(6,5895)XXDD,YYDD
 5895 FORMAT(20X,*X AND Y COORDINATES OF UPPER BLADE END POINT=*,1H(,
     X F7.5,1H,,F7.5)
      WRITE (6,5690) TH,XXH
      WRITE(6,5551) BETAB,BETAC
      WRITE(6,555) R,AAAA,BBBB,CCCC
      WRITE(6,566) A8,B8,C8,D8
      WRITE(6,567) XROOVD,A2AA,B2BB,C2CC
      WRITE (6,523) AAAAU,BBBBU,CCCCU
      WRITE(6,524) A8U,B8U,C8U,D8U
      WRITE(6,525) A2AAU,B2BBU,C2CCU
      WRITE(6,1229) LPMS,LPKS,SBETA,IREAD,NCHBY
      WRITE(6,1324) DE,DG,DF,SF4
      WRITE(6,1521) SBETA2
  590 FORMAT (8F10.8)
  591 FORMAT (10X,*DELTA(I,J)=*,6(F10.8,2X))
 5690 FORMAT (20X,*THICKNESS OF PLAND COV/EX FOIL = *,F10.5,10X,*XXH=*,
     1F10.5)
  525 FORMAT(20X,*A2AAU=*,F10.6,2X,*B2BBU=*,F10.6,2X*C2CCU=*,F10.6)
  555 FORMAT(20X,*R=*,F5.2,2X,*AAAA=*,F10.6,2X,*BBBB=*,F10.6,2X,*CCCC=*,
     XF10.6)
  566 FORMAT(20X,*A8=*,F10.6,2X,*B8=*,F10.6,2X,*C8=*,F10.6,2X,*D8=*,F10.
     X6)
  567 FORMAT(20X,*XROOVD=*,F10.6,2X,*A2AA=*,F10.6,2X,*B2BB=*,F10.6,2X,*C
     X2CC=*,F10.6)
  523 FORMAT(20X,*AAAAU=*,F10.6,2X,*BBBBU=*,F10.6,2X,*CCCCU=*,F10.6)
  524 FORMAT(20X,*A8U=*,F10.6,2X,*B8U=*,F10.6,2X,*C8U=*,F10.6,2X,*D8U=*,
     1 F10.6)
C  IFLAG1*****IFLAG=1 FOR THE FIRST RUN & IFLAG=0 FOR PREVIOUS DATA USE.
C IFLAG1=0 FOR REGULAR RUNS, IFLAGINE0FOR RUNS OF READING DATA FROM CASCLIM.
C IF IFLAGINE.0 NEED EXTRA DATA FOR SXSI(2) AND SXSI(3).
  788 FORMAT(3I10)
C AAAA,BBBB,CCCCARE CONSTANTS FOR 2-TERM CAMBER, X AND SQRT(X)
C  ********CALCULATED FROMANOTHER PROGRAM CALLED *CAMBER**********.
C A8,B8,C8 AND D8 ARE COEFFICIENTS FOR POLYNOMIALS FOR X GREATER THAN .8.
C A8AU,A2AAU,A8U ETC... ARE THE SAME AS AAAA ETC... EXCEPT THEY ARE
C FOR THE UPPER FACE OF THE FOIL
C CLDD AND CLDDX ARE NOW OBSOLETE.
C SF4 IS USED FOR DETERMINING WHETHER TO CALCULATE BETA.
 1321 FORMAT(5E14.7)
C IFLAG=1 NEEDS DATA CARDS FOR SXSI(I), I=1,5, IREAD MAY BE SET TO 5.
C IF IFLAG=0 , DATA WILL BE READ EITHER FROM
C        DATA CARD, IF IREAD=5
C        TAPE1    , IF IREAD=1.
  551 FORMAT(10I8)
  201 FORMAT(4I3)
  202 FORMAT(4E14.7)
C DE,DG,DF ARE THE INCREMENTS FOR DERIVATIVES IN DXFNED.
```

```
C DS=1.E-3 $ DF=1.E-5 ARE USED BEFORE.
  229 FORMAT(3E14.7)
 1229 FORMAT(5X,4HLPM=,I4,2X,4HLP2=,I4,2X,6HSBETA=,E14.7,5X,6HIREAD=,I1,
     X2X,4HNCHBY=,I3)
 5551 FORMAT(20X,'BETAB AND BETAC AS FIRST GUESS=',F10.5,2X,F10.5)
 1324 FORMAT(10X,3HDE=,E14.7,2X,3HDS=,E14.7,3HDF=,E14.7,2X,4HSF4=,E14.7)
 1521 FORMAT(10X,'SBETA2=',E14.7)
      SBETA2=SBETA2*PAI/180.
      BETAB=BETAB*PAI/180.
      BETAC=BETAC*PAI/180.
C  LPMM=LPM2=NS2
      LPMM=LPM2
      NS2=LPM2
      LPMM1=LPMM+1
      WRITE(6,1469) LPM2,ISHARP
 1469 FORMAT(10X,'LPM2=',I3,2X,'ISHARP=',E14.7)
C ISHARP=0 FOR SHARP L.E.
C        1 FOR ROUNDED L.E.
      SBETA=SBETA*PAI/180.
      DO 999 IJKL=1,NITER
C FFF4 IS PROVIDED FROM DKENE., BUT IF THE LOOP DOES NOT GO THROUTH
C     IT, FFF4 OF PRESET VALUE MUST BE USED.
      FFF4=0.
      ALFA1D=ALFA1S
      GAMMAD=GAMMAS
      SOLID=SOLIS
      SIGMA=SIGMS
      IF(NHK.EQ.1) GO TO 240
      IF(NHK.EQ.2) GO TO 241
      IF(NHK.EQ.3) GO TO 242
      SIGMA=SIGMS-0.01*FLOAT(IJKL-1)
      GO TO 243
  242 SOLID=SOLIS+0.1*FLOAT(IJKL-1)
      GO TO 243
  241 GAMMAD=GAMMAS+2.*FLOAT(IJKL-1)
      GO TO 243
  240 ALFA1D=ALFA1S-2.*FLOAT(IJKL-1)
  243 CONTINUE
      XM=XXM
      ALFA1=ALFA1D*PAI/180.
      DSAP=1./SOLID
      GAMMA=GAMMAD*PAI/180.
      DELTA=ALFA1+GAMMA
      FLAPAN=0.
      WRITE(6,666) ALFA1D,GAMMAD,SOLID
  666 FORMAT(1X,18HINCIDENCE ANGLE=,E14.7,1X,6HGAMMA=,E14.7,1X,9HSOLIDIT
     XY=,E14.7)
      WRITE(6,663) FLAPAN
  663 FORMAT(5X,11HFLAP ANGLE=,E14.7)
      STOLL=2.E-4
      STOLS=5.E-4
      ERC=1.E-2
      C_E=1.E-4
C CAVIT. NO.=SIGMA, AND PSIZ.
      WRITE(6,511) SIGMA
  511 FORMAT(10X,11HCAVIT. NO =,E14.7)
      CCC1=ALOG(1.+SIGMA)/(2.*PAI)
C SPECIFY HYDROFOIL'S CHARACTERISTICS AND SEP. POINTS.
      XC=0.
      YC=0.
```

```
      XB=0.
      XA=1.
      WRITE(6,502)XA,XB,XC,YC,XXDD,YYDD
  502 FORMAT(10X,6HCHORD=,E14.7,2X,17HUPPER SEP. POINT=,E14.7,2X,20HCONN
     X. POINT(XC,YC)=(,E14.7,1H,,E14.7,1H)/*  XXDD=*,F10.6,2X,*YYDD=*,
     Y F10.6)
C START ITERATIVE PROCEDURE.
C     -----BASIC FLOW IS THAT OF FLAT PLATE-----.
C ITERAT IS INDEX FOR NUMBER OF ITERATIONS.
      ITERA=1
      IF(IFLAG.EQ.0) ITERA=2
      BIGS=0.
      XHIGH=0.
      XLOW=0.
      IS112=0
      XINCRT=XA/50.
      DO 248 IINC=1,50
      XLOW=XHIGH
      XHIGH=XLOW+XINCRT
      CALL ARCLEN(S,XLOW,XHIGH,IS112)
  248 BIGS=BIGS+S
      WRITE(6,504) BIGS
  504 FORMAT(10X,5HBIGS=,E14.7)
      STOL=1.E-5
      LPM=LPMS
      LPK=LPKS
      LPM1=LPM-1
      LPM3=LPM-3
C ICPI IS USED FOR CONTROLLING PROGRAM; 0 FOR ITER. 1 FOR THE REST.
C FIND XSIB,XSIC,XSIF,A,A_F2 BY USING NEWTON,S METHOD.
C SXSI(1)=XSIB
C SXSI(2)=XSIC
C SXSI(3)=XSIF
C SXSI(4)=A WHICH IS THE COEFFT. OF MAPPING FCN.
C SXSI(5)=A_F2
C SXSI(6)=ESPACE (RATIO OF SPACE OF BLADES AT UPSTREAM AND DOWNSTREAM)
      IF(ICKL.GE.2) GO TO 630
      IF(IFLAG.EQ.0) GO TO 761
C INATIAL GUESS FOR SXSI(I) IS ----------
      READ(5,768) SXSI(1),SXSI(2),SXSI(3),SXSI(4),SXSI(5),SXSI(6)
      GO TO 160
C THIS IS THE CASE THAT OLD DATA ARE USED WITH PUNCHED CARDS.
  761 CONTINUE
      IF(IFLAG1.EQ.0) GO TO 779
      READ(1,620) SXSI(1),SXSI(2),SXSI(3),SXSI(4)
      SXSI(5)=SXSI(3)
      READ(5,779) SXSI(2),SXSI(3)
  778 FORMAT(2E14.7)
      GO TO 629
  779 READ(IREAD,620) SXSI(1),SXSI(2),SXSI(3),SXSI(4),SXSI(5),SXSI(6)
  620 FORMAT(6E13.6)
  629 DO 621 IC=1,LPM
  621 READ(IREAD,622) SARC(IC),BETAN(IC)
  622 FORMAT(2E14.7)
      DO 1621 IC=1,LPMM1
 1621 READ(IREAD,622) SARC2(IC),BETAN2(IC)
      IF(IFLAG.EQ.0) GO TO 480
      GO TO 481
  480 DO 482 IBT=1,LPM1
  482 BETAM(IBT)=.5*(BETAN(IBT)+BETAN(IBT+1))
```

```
  431 CONTINUE
  150 ICPI=0
      WRITE(6,102) ITERA
  102 FORMAT(10X,14HITERATION NO.=,I2)
      DO 650 IRP=1,6
  650 SXSIO(IRP)=SXSI(IRP)
      IF(ITERA.GE.2) STOL=STOLS
      IF(ITERA.EQ.MSTOP) STOL=STOLL
C
C
C
C
      CALL DXFNEW(SXSI,STOL,MAXIT,ITN,DS,DF,FFF4)
C
C
C
C
  630 CONTINUE
      DO 537 IC1=1,6
      XSN(IC1)=SXSI(IC1)
  537 WRITE(6,536) IC1,SXSI(IC1)
  536 FORMAT(10X,6HSXSI(,I1,2H)=,E14.7)
      CSPACE=(1.+SXSI(1))/FLOAT(LP1)
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(LP1-LP1)
      HFSPAC=0.5*FSPACE
      XBET=-1.+CSPACE*FLOAT(LP1-1)
      ICPI=1
C ICPI=0 FOR FINDING SXSI(I), I.E., SXSI(I)=YXS(I)≥ ICPI=1 FOR THE REST.
C CALCULATION OF PRESSURE DISTRIBUTION CP1.
      IF(ITERA.EQ.1) GO TO 36
      DO 35 IB=1,LP1
   35 BETAN0(IB)=BETAN(IB)
      DO 37 IB=1,LP11
   37 BETAM0(IB)=BETAM(IB)
      DO 355 IB=1,LP1M1
  355 BETA02(IB) = BETAN2(IB)
   36 CONTINUE
      JJ2=COS(ALFA1+GAMMA)/COS(SXSI(5)+GAMMA)/SXSI(5)
C                                    )AMMAG+)5(ISXS(SOC/)AMMAG+1AFLA(SOC=2UU
      JJ22=JJ2**2
      DO 25 LQ=1,LP1
      LP=LQ
C FIND CP(XSIP) NEXT.
C----- FOR THE FIRST WETTED ARC PORTION S1-----
C     CP IS BASED  ON J1 AND P1.
C     LP=1 IS NEAR THE T.E.
C     LP=LP1 IS NEAR THE L.E.
      IF(LP.EQ.1)  GO TO 521
      IF(LP.EQ.LP1) GO TO 52
      G2=EXP(XITN(LP))
C XITN(I) IS CALCULATED IN DFSIM2 OF DXFNEW FOR F(4).
      G2=G2**2
      CP(LP)=1.-JJ22*G2
      GO TO 522
   52 CP(LP)=-SIGMA
      GO TO 522
  521 CP(LP)=1.-JJ22
  522 CONTINUE
   25 CONTINUE
```

```
C                                                        EUNITNOC 431
C                                                        .0=)MPL(PC
C                          )3,021X,PCY,PCX(NEKTIA=)1-MPL(PC
C                          )3,911X,PCY,PCX(NEKTIA=)2-MPL(PC
C                                              ECAPSF-)1(ISXS=021X
C                                          ECAPSF*.2-)1(ISXS=911X
C                                                        .0=)4(PCY
C                                                )3-MPL(PC=)3(PCY
C                                                )5-MPL(PC=)2(PCY
C                                                )7-MPL(PC=)1(PCY
C                                                    )1(ISXS=)4(PCX
C                                         ECAPSF*.2+)2(PCX=)3(PCX
C                                         ECAPSF*.2+)1(PCX=)2(PCX
C                                        ECAPSF*.7-)1(ISXS=)1(PCX
C                                        431 OT OG )1.QE.ARETI(FI
C                                                                      *
C
C**********MAIN INSERT 1************************************************
C                                                                      *
C                                                                      *
C------CP FOR THE SECOND ARC S2-------
C         NUMBER OF CONTROL POINTS ON S2 IS FIXED
C         IN SUBROUTINE DFSIM5. I.E.,
C            HALF OF THE POINT USED FOR BETA
C         ANSG2S IN COMMON = G2.
      DO 680 NCP = 1,LPMM1
      IF(NCP.EQ.1) GO TO 681
      IF (NCP.EQ.LPMM1) GO TO 682
      G2 = EXP(ANSG2S(NCP))
      G2 = G2**2
      CP2(NCP) = 1.-G2*UU22
      GO TO 680
  681 CP2(NCP) = -SIGMA
      GO TO 680
  682 CP2(NCP) = 1.-UU22
  680 CONTINUE
C                                                                      *
C                                                                      *
C**********MAIN INSERT 1************************************************
C
C
      AF4=ABS(FFF4)
      IF(AF4.GE.SF4) GO TO 1135
      GO TO 1134
 1135 WRITE(5,1136)
 1136 FORMAT(5X,*F(4) IS TOO LARGE TO CALCULATE BETA*)
      STOP
C FIND XXX(XSIP) FIRST.
 1134 CONTINUE     .
      IS1S2=0
C-----FIRST BETA FOR ARC 1-----.
      DO 100 LLP=1,LPM
      LP=LPM-LLP+1
      CALL BBBETA(XYX,BETA,IS1S2)
      XXX(LP)=XYX
      BETAN(LP)=BETA
      IF(LP.EQ.LPM) BETAB=BETA
      IF(ITERA.LE.MSTOP1) GO TO 100
      WRITE(5,101) LP,SARC(LP),XXX(LP),CP(LP),BETAN(LP)
  100 CONTINUE
```

```
  101 FORMAT(1X,24I=,I3,1X,5HSARC=,E14.7,1X,4HXXX=,E14.7,1X,5HCP=,E14.7,
     X1X,6HBETAN=,E14.7)
C
C
C**********MAIN INSERT 2*************************************************
C                                                                       *
C                                                                       *
C----------BETA FOR ARC S2-----------------------.
C            SARC2 HAS BEEN CALCULATED
C            IN SUBROUTINE OFSIM5 AND
C            STORED IN COMMON AREA.
      IS1S2 = 1
      DO 429 LLP=1,LPMM1
      LP=LLP
      CALL BBBETA(XYX,BETA,IS1S2)
      IF(LP.EQ.1) BETAC=BETA
      XXX2(LP) = XYX
      BETAN2(LP) = BETA
      IF(ITERA.LE.MSTOP1) GO TO 329
      WRITE(6,239) LP,SARC2(LP),XXX2(LP),CP2(LP),BETAN2(LP)
  239 FORMAT(9X,*I=*,I3,1X,*SARC2=*,E14.7,1X,*XXX2=*,
     *E14.7,1X,*CP2=*,E14.7,1X,*BETAN2=*,E14.7)
  329 CONTINUE
  429 CONTINUE
C                                                                       *
C                                                                       *
C**********MAIN INSERT 2*************************************************
C
C**********MAIN INSERT 3 *************************************************
C                                                                       *
C                                                                       *
C FIND LIFT AND DRAG.
C----------FIRST CL AND CD FOR S1 PART.
      USID = SIN(DELTA)
      UCOD = COS(DELTA)
      UXB = SXSI(4)*UCOD
      UXB2 = UXB**2
      DO 105 ITK = 1,LPM
      IF(ITK.GT.LPK) GO TO 106
      XPS = -1.*DSPACE*FLOAT(ITK-1)
      GO TO 108
  106 XPS = XBET+FSPACE*FLOAT(ITK-LPK)
  108 CONTINUE
      UXA = XPS-SXSI(4)*USID
      UXA2 = UXA**2
      PKXP = UCOD/(UXA2+UXB2)
      DWDX = DGAP*PKXP*XPS/PAI
      COBET1      = COS(BETAN(ITK))
      SIBET1      = SIN(BETAN(ITK))
      DS1DX = -EXP(-XITN(ITK))*DWDX/UU22
C     S1 IS CALCULATED AT OFSIM2 AS XITN(I).
C     AND STORED IN COMMON.
      IF(XPS.LT.0.) DS1DX = -DS1DX
      XLP1 = DS1DX*CP(ITK)
      FL(ITK) = -XLP1*COBET1
      FD(ITK) = XLP1*SIBET1
  105 CONTINUE
C-----CL AND CD FOR S2 PART.
      NS21=NS2+1
```

```
      NS2A=NS2-1
      GAP2 = (SXSI(3)-SXSI(2))/NS2
      DO 338 ITK = 1, NS21
      XRS2 = SXSI(2)+GAP2*(ITK-1)
      UXA = XRS2-SXSI(4)+USID
      UXA2 = UXA**2
      PXXP = UCOD/(UXA2+UX82)
      DADX = DGAP*PXXP*XRS2/PAI
      COBET2 =-COS(BETAN2(ITK))
      SIBET2 =-SIN(BETAN2(ITK))
      DS2DX = EXP(-ANSG2S(ITK))*DADX/JJ22
C     G2 IS ALREADY CALCULATED AT OFSIM5 AS
C     ANSG2S(I), STORED IN COMMON AREA.
      X_P2 =  DS2DX*CP2(ITK)
      F_2(ITK) =-X_P2*COBET2
      FD2(ITK) =  X_P2*SIBET2
  338 CONTINUE
      SPACE = CSPACE
      CLIFT = 0.5*CSPACE*F_(2)+0.5*FSPACE*FL(LPM1)
      CDRAG = 0.5*CSPACE*FD(2)+0.5*FSPACE*FD(LPM1)
      DO 111 IUA = 2,LPM3,2
      IF(IUA.GE.LPK) SPACE = FSPACE
      CLIFT = CLIFT+SPACE*(F_(IUA)+4.*F_(IUA+1)+F_(IUA+2))/3.
  111 CDRAG = CDRAG+SPACE*(FD(IUA)+4.*FD(IUA+1)+FD(IUA+2))/3.
      DO 321 IUA = 1,NS2A,2
      CLIFT = CLIFT+GAP2*(FL2(IUA)+4.*FL2(IUA+1)+FL2(IUA+2))/3.
  321 CDRAG = CDRAG+GAP2*(FD2(IUA)+4.*FD2(IUA+1)+FD2(IUA+2))/3.
C-----ADD THE FORCES ON CAVITY PORTIONS.
C     SUBROUTINE XCYC CALCULATES
C   THE POINT ON THE UPPER BLADE PORTION CORRESP. TO THE CAVITY END POINT.
      CXA=XCCC
      CYA=YCCC
      CALL XCYC(XCCCB,YCCCB,CXA,CYA)
      CLIFT = CLIFT+SIGMA*XCCCB
      CDRAG = CDRAG-SIGMA*YCCCB
C-----XCCC AND YCCC ARE THE END POINTS OF CAVITY, CALCULATED IN
C     SUBROUTINE CAVITY
C     STORED IN COMMON.
C                                                                              *
C                                                                              *
C**********MAIN INSERT 3 ***************************************************
C
C
C FIND BINF IN Z-1.
      U2U1=COS(ALFA1+GAMMA)/COS(SXSI(5)+GAMMA)/SXSI(6)
      DOWN=COS(ALFA1+GAMMA)*COS(SXSI(5)+GAMMA)/SXSI(6)
      BINF=0.5*SIN(ALFA1+SXSI(5)+2.*GAMMA)/DOWN
      BINF=ATAN(1./BINF)
      AINF=0.5*PAI-BINF-GAMMA
C CDSTAR AND CLSTAR ARE BASED ON VELOCITY AT UPSTREAM INFINITY IN (X,Y).
      CDSTAR=CDRAG
      CLSTAR=CLIFT
      UINF=0.5*SQRT(1.+U2U1**2+2.*U2U1*COS(ALFA1-SXSI(5)))
      FINF=2.*DGAP*SIN(ALFA1-SXSI(5))/(UINF*COS(SXSI(5)+GAMMA))
      CLINF=CLSTAR*COS(AINF)-CDSTAR*SIN(AINF)
      CDINF=CLSTAR*SIN(AINF)+CDSTAR*COS(AINF)
      CLINF=CLINF/UINF**2
      CDINF=CDINF/UINF**2
      WRITE(6,117) CLINF,CDINF
  117 FORMAT(1X,34HCLINF OR CDINF=FORCE/1/2RO.UINF**2,5X,6HCLINF=,E14.7,
```

```
     X1X,6HCDINF=,E14.7)
      WRITE(6,118) FINF
  118 FORMAT(1X,34HFINF IS OBTAINED FROM MOMENTUM EQN,5HFINF=,E14.7)
      WRITE(6,221)
  221 FORMAT(1X,48H---CDLL & CDDD ARE BASED ON J1 IN ALFA1 DIRE.---)
      CDLL=CLSTAR*COS(ALFA1)-CDSTAR*SIN(ALFA1)
      CDDD=CLSTAR*SIN(ALFA1)+CDSTAR*COS(ALFA1)
      ALOD=CDLL/CDDD
      WRITE(6,191) CDDD,CDLL,ALOD
  191 FORMAT(1X,5HCDDD=,E14.7,1X,5HCDLL=,E14.7,1X,4HL/D=,E14.7)
      MSTOP1=MSTOP-1
      IF(ITERA.LE.MSTOP1) GO TO 140
C
C
C**********MAIN INSERT 4 ************************************************************
C                                                                                     *
C                                                                                     *
C     CAVITY SHAPE.
C        ALREADY CALCULATED IN
C        SUBROUTINE CAVITY.
      WRITE(6,237)
  237 FORMAT(2X,'----CAVITY SHAPE------')
      NCAV1=NCAV+1
      DO 235 KCAV=1,NCAV1,2
  235 WRITE(6,236) CAVX(KCAV ),CAVY(KCAV )
  236 FORMAT(10X,'X=',E14.7,10X,'Y=',E14.7)
C                                                                                     *
C                                                                                     *
C**********MAIN INSERT 4 ************************************************************
C
C
  140 CONTINUE
      KCCC=0.
      YCCC=0.
      WRITE(6,823)
  823 FORMAT(//,'------------UPPER BODY SHAPE----------')
      DO 821 IS4P=1,51
      X=.02*(IS4P-1)
      CALL SHAPE (X,Y,BETA,3)
  821 WRITE(6,822) X,Y
  822 FORMAT(5X,'X=',F10.5,2X,'Y=',F10.5)
      REWIND 7
      WRITE(7,768) SXSI(1),SXSI(2),SXSI(3),SXSI(4),SXSI(5),SXSI(6)
  768 FORMAT(6E13.6)
      DO 766 IC=1,LPM
  766 WRITE(7,767) SARC(IC),BETAN(IC)
  767 FORMAT(2E14.7)
      DO 1766 IC=1,LPMM1
 1766 WRITE(7,767) SARC2(IC),BETAN2(IC)
      IF(ITERA.GE.MSTOP) GO TO 999
      LPK1=LPK-1
      SPACE=CSPACE
      HSPACE=HCSPAC
      DO 50 IM=1,LPK1
      IF(IM.EQ.1) GO TO 51
      IF(IM.EQ.LPK1) GO TO 55
      IF(IM.EQ.LPK(1) GO TO 57
      IF(IM.EQ.LPK() GO TO 93
      IF(IM.GT.LPK() GO TO 93
      XY=-1.+SPACE*FLOAT(IM-1)+HSPACE
```

```
      XZ(1)=-1.*SPACE*FLOAT(IM-2)
      XZ(2)=XZ(1)+SPACE
      XZ(3)=XZ(2)+SPACE
      XZ(4)=XZ(3)+SPACE
      GO TO 99
   93 SPACE=FSPACE
      HSPACE=HFSPAC
      XY=XBET+HSPACE+ SPACE*FLOAT(I4-LPK)
      XZ(1)=XBET+SPACE*FLOAT(IM-LPK-1)
      XZ(2)=XZ(1)+SPACE
      XZ(3)=XZ(2)+SPACE
      XZ(4)=XZ(3)+SPACE
   99 DO 56 IK=1,4
   56 YBE(IK)=BETAN(IM+IK-2)
      BETAM(IM)=AIT(EV(XZ,YBE,XY,3)
      GO TO 151
   97 BETAM(LPK1)=0.5*(BETAN(LP(1)+BETAN(LPK))
      GO TO 151
   98 BETAM(LPK)=0.5*(BETAN(LPK)+BETAN(LPK+1))
      GO TO 151
   51 BETAM(1)=0.5*(BETAN(1)+BETAN(2))
      GO TO 151
   55 BETAM(LPM1)=0.5*(BETAN(LPM1)+BETAN(LPM))
  151 CONTINUE
   50 CONTINUE
      IF(ITERA.EQ.1) GO TO 6
      DO 41 IE=1,LPM
   41 BETAN(IE)=BETAN(IE)*(1.-XXM)+BETANO(IE)*XXM
      DO 42 IFG=1,LPM1
   42 BETAM(IFG)=BETAM(IFG)*(1.-XXM)+BETAMO(IFG)*XXM
      DO 425 IFG=1,LPM1
  425  BETAN2(IFG) = BETAN2(IFG)*(1.-XXM)+BETAO2(IFG)*XXM
      DO 852 IRP=1,6
  852 SXSI(IRP)=SXSI(IRP)*(1.-XXM)+SXSIO(IRP)*XXM
    6 ITERA=ITERA+1
      IF(ITERA.GT.MSTOP) GO TO 28
      GO TO 160
   28 WRITE(6,29)
   29 FORMAT(5X,26HITERATION WAS TERMAINATED.)
  999 CONTINUE
      STOP
      END
```

vv

```
      SUBROUTINE OXFNE+(X,STOL,M,I,DG,DF,FFF4)
      DIMENSION F(6),P(50,6),X(6),A(6,6),XRRI(6),XMMI(6)
      COMMON/DE_TAD/DELT(6,6)
      COMMON/FREECAV/XFREEC,YFREEC
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,_PMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFAI,GAMMA
      COMMON SIGMA,SBETA,XKM,ICPI,SARCOD(513)
      COMMON IDJ_,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSV(6),CCC1,CLE,ERC,YY,XM,IFERA,SXSID(6),SYSIDD(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B23B,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAJS(100),AGAUS(100),NGAUS
      PAI=3.141592653
      I=0
      IF(ITERA._E.3) GO TO 272
      DO 67 IIJ=1,6
   67 WRITE(6,66) IIJ,X(IIJ)
   66 FORMAT(1X,2HX(,I1,2H)=,E14.7)
  272 CONTINUE
   55 SI1=2.*DE
      SI6=2.*DG
      IF(X(1)._LT.SI1) X(1)=SI1
      SI10=X(1)+2.*DG
      IF(X(2)._LT.SI10) X(2)=SI10
      SI11=X(2)+2.*DG
      IF(X(3)._LT.SI11) X(3)=SI11
      IF(X(4)._LT.SI6) X(4)=SI6
      SI5=(0.5*PAI-GAMMA)*(1.-0.02)
      IF(X(5)._LT.0.) GO TO 75
      IF(X(5)._GT.SI5) X(5)=SI5
      GO TO 79
   78 IF(ABS(X(5))._GT.SI5) X(5)=-SI5
   79 CONTINUE
      IF (X(6)._LE.0.) WRITE(6,1122)
      DO 68 IIJ=1,6
   68 WRITE(6,66) IIJ,X(IIJ)
      IJ=1
C------F(1)-----------------------------------------------------------------
      DO 20 IK=1,6
   20 YXS(IK)=X(IK)
    5 CONTINUE
      KCTRL = 1
      CALL F1INT_(YINT1,KCTRL)
C     SUBROUTINE F1INTL CALCULATES THE INTEGRALS IN F(1).
      KCTRL = 2
      CALL F1INTL (YINT2,KCTRL)
      KCTRL = 3
      CALL F1INT_ (YINT3,KCTRL)
      KCTRL = 4
      CALL F1INT_ (YINT4,KCTRL)
      CS1=ALOG(COS(YXS(5)+GAMMA)/COS(ALFA1+GAMMA)+YXS(6))
C                          ))AMMAG+1AFLA(SOC/)AMMA3+)5(SXY(SJC(GGLA = 1SC
      FA = -(YINT1/PAI+YINT2-(CCC1+CS1/PAI)+YINT3
     1+YINT4/PAI-YXS(5))
C                         +TNIY,3TNIY,2TNIY,1TNIY )07,5( ETIRA )1.3E.JI( FI
```

```
                ))X2,7,X1E(4,*---ERA )1(F FO 4I,3I,2I,1I----*,XC1( TA4ROF 07
      IF (IJ.EQ.1) F(1) = FA
      IF (IJ.EQ.2) GO TO 3
      IF (IJ.EQ.3) GO TO 4
      IF (IJ.EQ.4) GO TO 320
      IF (IJ.EQ.5) GO TO 321
      IF (IJ.EQ.6) GO TO 322
      IF(IJ.EQ.66) GO TO 3222
      P(1,6)=-YINT3/(PAI*Y(S(6))
      P(1,5) = TAN(YXS(5)+GAMMA)*YINT3/PAI-1.
      IJ = 2
      YXS(1) = X(1)+DELT(1,1)
      GO TO 5
    3 F1P = -FA
      IJ = 3
      Y(S(1) = X(1)-DELT(1,1)
      GO TO 5
    4 F1Q = -FA
      P(1,1) = (F1P-F1Q)/(2.*DELT(1,1))
      IJ = 4
      YXS(1) = X(1)
      YXS(2) = X(2)+DELT(1,2)
      GO TO 5
  320 F1P = -FA
      YXS(2) = X(2)-DELT(1,2)
      IJ = 5
      GO TO 5
  321 F1Q = -FA
      P(1,2) = (F1P-F1Q)/(2.*DELT(1,2))
      Y(S(2) = X(2)
      YXS(3) = X(3)+DELT(1,3)
      IJ = 6
      GO TO 5
  322 F1P = -FA
      IJ=66
      YXS(3)=X(3)-DELT(1,3)
      GO TO 5
 3222 F1Q=-FA
      P(1,3) = (F1P-F1Q)/(2.*DELT(1,3))
      P(1,4) = 0.
C-----F(2) AND F(3)-------------------------------------------------------
      DO 30 IM=1,6
   30 YXS(IM)=X(IM)
      IJ = 7
  330 CONTINUE
      XXXX=ACOS(COS(A_FA1+GAMMA)/COS(YXS(3)+GAMMA)/YXS(6))
C                          ))AMMAG+)5(SXY(SOC/)AMMAG+IAFLA(SOC(GCLA = XKKX
      XX1  = YXS(4)+SIN(DEL_TA)
      YY1  = YXS(4)+COS(DEL_TA)
      YY12=YY1**2
      CON1 = CCC1-XXXX/PAI
      XRR = 0.
      XMM = 0.
      DO 331 MIG = 1,4
      CALL RMINT(SOLVR,SOLVM,MIG)
      XRRI(MIG) = SOLVR
      XMMI (MIG) = SOLVM
      XRRR = -XRRI(MIG)/PAI
      XMMM = -XMMI(MIG)/PAI
      IF (MIG.EQ.1) XRRR = CON1+XRRI(MIG)
```

```
      IF (MIQ.EQ.1) XMMM = CON1*YMMI(MIQ)
      IF (MIQ.EQ.4) XRRR = -XRRI(MIQ)
      IF (MIQ.EQ.4) XMMM = -XMMI(MIQ)
C                                  )4,1=I,)I(IRRX( )17,5( ETIR, )7.2E.JI( FI
C                                  )4,1=I,)I(IMMX( )27,5( ETIR, )7.2E.JI( FI
C       ))X2,7,*1E(4,,---ERA )3(F DVA )2(F FO 4,1=I,)I(IRRX----*,X01(TAMRCF 17
C       ))X2,7,*1E(4,,---ERA )3(F DVA )2(F FO 4,1=I,)I(IMMX----*,X01(TAMROF 27
      XRR = XRR+XRRR
      XMM = XMM+XMMM
  331 CONTINUE
C-----CALCULATION OF H1(ZETA1)-------.
      XSIP1 = XX1+1.
      XSIMB = XX1-YYS(1)
      XSIMF = XX1-YYS(3)
      XSIMC = XX1-YYS(2)
      XSIP12 = XSIP1**2
      XSIMB2 = XSIMB**2
      XSIMF2 = XSIMF**2
      XSIMC2 = XSIMC**2
      RRA = SQRT(XSIP12+YY12)
      RRB = SQRT(XSIMB2+YY12)
      RRC = SQRT(XSIMF2+YY12)
      RRD = SQRT(XSIMC2+YY12)
      THIA = ATAN(YY1/XSIP1)
      IF (XSIP1.LE.0.) THIA = PAI+THIA
      THIB = ATAN(YY1/XSIMB)
      IF (XSIMB.LE.0.) THIB = PAI+THIB
      THIC = ATAN(YY1/XSIMF)
      IF (XSIMF.LE.0.) THIC = PAI+THIC
      THID = ATAN(YY1/XSIMC)
      IF (XSIMC.LE.0.) THID = PAI+THID
      RR1 = SQRT(RRA*RRB*RRC/RRD)
      THIT1 = .5*(THIA+THIB+THIC-THID)
      COTH1 = COS(THIT1)
      SITH1 = SIN(THIT1)
      F2CO = RR1*(XRR*COTH1-XMM*SITH1)-ALFA1
      F3CO = RR1*(XRR*SITH1+XMM*COTH1)+XXXX
      IF (IJ.EQ.7) F(2) = -F2CO
      IF (IJ.EQ.7) F(3) = -F3CO
      IF (IJ.EQ.8) GO TO 340
      IF (IJ.EQ.9) GO TO 341
      IF (IJ.EQ.10) GO TO 342
      IF (IJ.EQ.11) GO TO 343
      IF (IJ.EQ.12) GO TO 344
      IF (IJ.EQ.13) GO TO 345
      IF (IJ.EQ.14) GO TO 346
      IF (IJ.EQ.15) GO TO 347
      TA2G =  TAN(YYS(5)+GAMMA)
      XSXC = XRRI(1)*SITH1+XMMI(1)*COTH1
      XCXS = XRRI(1)*COTH1-XMMI(1)*SITH1
      P(2,5) = -RR1*TA2G*XCXS
      P(2,5) = P(2,5)/PAI
      P(3,5) = -RR1*TA2G*XSXC
      P(3,5) = P(3,5)/PAI+TA2G
      P(2,6) = RR1*XCXS/(PAI*YYS(5))
      P(3,6) = RR1*XSXC/(PAI*YYS(5))-1./YYS(6)
      IJ = 8
      YYS(1) = X(1)+DELT(1,2)
      GO TO 330
  340 FP2 = F2CO
```

```
      FP3 = F3CD
      IJ = 9
      YXS(1) = X(1)-DELT(2,1)
      GO TO 330
  341 P(2,1) = (FP2-F2CD)/(2.*DELT(2,1))
      P(3,1) = (FP3-F3CD)/(2.*DELT(2,1))
      YXS(1) = X(1)
      YXS(2) = X(2)+DELT(2,2)
      IJ = 10
      GO TO 330
  342 FP2 = F2CD
      FP3 = F3CD
      YXS(2) = X(2)-DELT(2,2)
      IJ=11
      GO TO 330
  343 P(2,2) = (FP2-F2CD)/(2.*DELT(2,2))
      P(3,2) = (FP3-F3CD)/(2.*DELT(2,2))
      YXS(2) = X(2)
      YXS(3) =   X(3)+DELT(2,3)
      IJ = 12
      GO TO 330
  344 FP2 = F2CD
      FP3 = F3CD
      YXS(3) = X(3)-DELT(2,3)
      IJ = 13
      GO TO 330
  345 P(2,3) = (FP2-F2CD)/(2.*DELT(2,3))
      P(3,3) = (FP3-F3CD)/(2.*DELT(2,3))
      YXS(4) = X(4)+DELT(2,4)
      YXS(3)=X(3)
      IJ=14
      GO TO 330
  346 FP2=F2CD
      FP3=F3CD
      YXS(4) = X(4)-DELT(2,4)
      IJ = 15
      GO TO 330
  347 P(2,4) = (FP2-F2CD)/(2.*DELT(2,4))
      P(3,4) = (FP3-F3CD)/(2.*DELT(2,4))
      YXS(4)=X(4)
C------F(4)-----------------------------------------------------------
      IJ=16
      YXS(1)=X(1)+DELT(4,1)
  199 CALL OFSIM2(ANS2)
      IF(IJ.EQ.15) GO TO 575
      IF(IJ.EQ.16) GO TO 513
      IF(IJ.EQ.17) GO TO 514
      IF(IJ.EQ.19) GO TO 515
      IF(IJ.EQ.20) GO TO 516
      IF(IJ.EQ.21) GO TO 517
      IF(IJ.EQ.22) GO TO 518
      IF(IJ.EQ.23) GO TO 521
      IF(IJ.EQ.24) GO TO 522
      IF(IJ.EQ.25) GO TO 523
      IF(IJ.EQ.26) GO TO 524
      IF (IJ.EQ.261) GO TO 525
      IF (IJ.EQ.262) GO TO 526
  513 ANSP=ANS2
      IJ=17
      YXS(1)=X(1)-DELT(4,1)
```

```
      GO TO 199
  614 ANS2=ANS2
      IJ=18
      P(4,1)=-(ANSP-ANS2)/(2.*DELT(4,1))
      YXS(1)=X(1)
      GO TO 199
  615 ANSP=ANS2
      P(4)=-(BIGS-ANSP)
      IJ=19
      YXS(2)=X(2)+DELT(4,2)*ABS(X(2))
      GO TO 199
  616 ANSPP=ANS2
      IJ=20
      YXS(2)=X(2)-DELT(4,2)*ABS(X(2))
      GO TO 199
  616 ANSQQ=ANS2
      P(4,2)=-(ANSPP-ANSQQ)/(2.*DELT(4,2)*ABS(X(2)))
      YXS(2)=X(2)
      IJ=21
      YXS(3)=X(3)+DELT(4,3)*X(3)
      GO TO 199
  617 ANS1P=ANS2
      IJ=22
      YXS(3)=X(3)-DELT(4,3)*X(3)
      GO TO 199
  618 ANS1Q=ANS2
      P(4,3)=-(ANS1P-ANS1Q)/(2.*DELT(4,3)*X(3))
      YXS(3)=X(3)
      IJ=23
      YXS(4)=X(4)+DELT(4,4)*ABS(X(4))
      GO TO 199
  621 ANA=ANS2
      IJ=24
      YXS(4)=X(4)-DELT(4,4)*ABS(X(4))
      GO TO 199
  622 ANB=ANS2
      P(4,4)=-(ANA-ANB)/(2.*DELT(4,4)*ABS(X(4)))
      YXS(4)=X(4)
      IJ=25
      YXS(5)=X(5)+DELT(4,5)
      GO TO 199
  623 BNA=ANS2
      IJ=26
      YXS(5)=X(5)-DELT(4,5)
      GO TO 199
  624 BNB=ANS2
      P(4,5)=-(BNA-BNB)/(2.*DELT(4,5))
      YXS(5)=X(5)
      FFF=P(4)
      YXS(5) = X(5)
      IJ = 261
      YXS(6) = X(6) + DELT(4,6)
      GO TO 199
  625 BNA = ANS2
      YXS(5) = X(5) - DELT(4,5)
      IJ=262
      GO TO 199
  626 BNB = ANS2
      P(4,6) = -(BNA-BNB)/(2.*DELT(4,5))
      YXS(6) = X(6)
```

```
C F(5) AND F(6)
C   FIRST CALCULATE THE PHYSICAL COORDINATES
C  FOR THE END POINT OF CAVITY.
C THIS SUBROUTINE FINDS THE END POINT OF CAVITY.
      IJ = 27
  815 CALL CAVITY (XCEND,YCEND)
C  THEN FIND S2- THE ARC LENGTH OF THE SECOND WETTED PORTION.
C  CALL SUBROUTINE ARCS2 FOR THIS PURPOSE.
      IF (IJ.EQ.27) YFREE=YCEND
      IF (IJ.EQ.27) XFREE=XCEND
C                                    )6,1=I,)I(SXY(,ONEDX,JI  )035,6(ETIRW
C                                    ))5.21E,X2(6,X5,5.21E,X5,3I,X1(TAHRCF 035
      CALL ARCS2 (S2,XCEND,YCEND)
C F(6)=YCEND-FUNCTION(XCEND)=0 TO BE SATISFIED.
      IS1I2=3
      CALL SHAPE(XCEND,YUPPER,BETA,IS1I2)
      WRITE(6,533) XCEND,S2,YUPPER
  533 FORMAT(5X,*XCEND=*,E12.5,5X,*S2=*,E12.5,5X,*YUPPER=*,E12.5)
      IF(IJ.EQ.27) BIGS2=S2
C  FINALLY GO INTO F(5) COMPUTATIONS.
      CALL DFSIMS(ANS5)
      IF(IJ.EQ.27) GO TO 820
      IF(IJ.EQ.28) GO TO 821
      IF (IJ.EQ.29) GO TO 822
      IF (IJ.EQ.30) GO TO 823
      IF (IJ.EQ.31) GO TO 824
      IF (IJ.EQ.32) GO TO 825
      IF (IJ.EQ.33) GO TO 826
      IF (IJ.EQ.34) GO TO 827
      IF(IJ.EQ.341) GO TO 830
      IF (IJ.EQ.35) GO TO 828
      IF (IJ.EQ.36) GO TO 829
      IF (IJ.EQ.37) GO TO 832
      IF (IJ.EQ.38) GO TO 833
  820 F(5) = -(S2-ANS5)
      F(6) = -(YCEND-YUPPER)
      IJ = 28
      YXS(1) = X(1)+DELT(5,1)
      GO TO 815
  821 ANP = ANS5-S2
      ANP6 = YCEND - YUPPER
      IJ = 29
      YXS(1) = X(1)-DELT(5,1)
      GO TO 815
  822 P(5,1) = -(ANP-(ANS5-S2))/(2.*DELT(5,1))
      ANG6 = YCEND-YUPPER
      P(6,1) = (ANP6 - ANG6)/(2.*DELT(5,1))
      YXS(1) = X(1)
      YXS(2) = X(2)+DELT(5,2)*ABS(X(2))
      IJ = 30
      GO TO 815
  823 ANP = ANS5-S2
      ANP6 = YCEND-YUPPER
      YXS(2) = X(2)-DELT(5,2)*ABS(X(2))
      IJ = 31
      GO TO 815
  824 P(5,2) = -(ANP-(ANS5-S2))/(2.*DELT(5,2)*ABS(X(2)))
      ANG6 = YCEND-YUPPER
      P(6,2) = (ANP6 - ANG6)/(2.*DELT(5,2)*ABS(X(2)))
      YXS(2) = X(2)
```

```
      IJ = 32
      YXS(3) = X(3)+DELT(5,3)*X(3)
      GO TO 815
  825 ANP = ANS5-S2
      ANP6 = YCENO - YUPPER
      YXS(3) = X(3)-DELT(5,3)*X(3)
      IJ = 33
      GO TO 815
  826 P(5,3) = -(ANP-(ANS5-S2))/(2.*DELT(5,3)*X(3))
      ANG6 = YCENO - YUPPER
      P(6,3) = (ANP6 - ANG6)/(2.*DELT(5,3)*X(3))
      IJ = 34
      YXS(3) = X(3)
      YXS(4) = X(4)+DELT(5,4)*ABS(X(4))
      GO TO 815
  827 ANP = ANS5-S2
      ANP6 = YCENO - YUPPER
      YXS(4) = X(4)-DELT(5,4)*ABS(X(4))
      IJ=341
      GO TO 815
  830 CONTINUE
      P(5,4) = -(ANP-(ANS5-S2))/(2.*DELT(5,4)*ABS(X(4)))
      ANG6 = YCENO - YUPPER
      P(6,4) = (ANP6 - ANG6)/(2.*DELT(5,4)*ABS(X(4)))
      YXS(4) = X(4)
      YXS(5) = X(5)+DELT(5,5)
      IJ = 35
      GO TO 815
  828 ANP = ANS5-S2
      ANP6 = YCENO-YUPPER
      YXS(5) = X(5)-DELT(5,5)
      IJ =36
      GO TO 815
  829 P(5,5) = -(ANP-(ANS5-S2))/(2.*DELT(5,5))
      ANG6 = YCENO - YUPPER
      P(6,5) = (ANP6 - ANG6)/(2.*DELT(5,5))
      YXS(5)=X(5)
      YXS(6)=X(6) + DELT(5,6)
      IJ= 37
      GO TO  815
  832 ANP = ANS5 - S2
      ANP6 = YCENO - YUPPER
      YXS(6) = X(6) - DELT(5,6)
      IJ= 38
      GO TO 815
  833 P(5,6) = -(ANP -(ANS5 - S2))/(2.*DELT(5,6))
      ANG6 = YCENO - YUPPER
      P(6,6) = (ANP6 - ANG6)/(2.*DELT(5,6))
      YXS(6) = X(6)
      DO 666 IK=1,6
  666 WRITE(6,667)(P(IK,J),J=1,6)
  667 FORMAT(3X,*P(I,J)=*,6(E14.7,2X))
      WRITE(6,251) BIGS2,XCCC,YCCC
  251 FORMAT(20X,*BIGS2=*,F10.5,2X,*XCCC=*,F10.5,2X,*YCCC=*,F10.5)
      NCAV1=NCAV+1
      DO 253 ICV=1,NCAV1,2
  253 WRITE(6,252) CAVX(ICV),CAVY(ICV)
  252 FORMAT(10X,*CAVX=*,F10.5,5X,*CAVY=*,F10.5)
      DO 129 ITX=1,6
  129 WRITE(6,131) ITX,P(ITX)
```

```
131 FORMAT(1X,2HF(,I1,2H)=,E14.7)
    DO 132 IUP=1,6
    IF(ITERA.LE.3) GO TO 385
    DO 132 IUQ=1,6
132 WRITE(6,133) IUP,IUQ,P(IUP,IUQ)
133 FORMAT(1X,2HP(,I1,1H,,I1,2H)=,E14.7)
385 CONTINUE
    CALL DETERM(P,6,DETBO)
    DO 25 IDET=1,6
    DO 26 LPG=1,6
    Q(LPG,IDET)=P(LPG,IDET)
 26 P(LPG,IDET)=F(LPG)
    CALL DETERM(P,6,DETE)
    IF(IDET.EQ.1) DELB=DETE/DETBO
    IF(IDET.EQ.2) DELC=DETE/DETBO
    IF(IDET.EQ.3) DELD=DETE/DETBO
    IF(IDET.EQ.4) DELE=DETE/DETBO
    IF(IDET.EQ.5) DELF=DETE/DETBO
    IF (IDET.EQ.6) DELG=DETE/DETBO
    DO 27 LPG=1,6
 27 P(LPG,IDET)=Q(LPG,IDET)
 25 CONTINUE
    X(1)=X(1)+DELB
    X(2)=X(2)+DELC
    X(3)=X(3)+DELD
    X(4)=X(4)+DELE
    X(5)=X(5)+DELF
    X(6) = X(6) + DELG
    DO 60 LMN=1,6
 60 WRITE(6,61) LMN,X(LMN)
 61 FORMAT(1X,2HX(,I1,2H)=,E14.7)
    ABSB=ABS(DELB/X(1))
    ABSC=ABS(DELC/X(2))
    ABSD=ABS(DELD/X(3))
    ABSE=ABS(DELE/X(4))
    ABSF=ABS(DELF/X(5))
    ABSG = ABS(DELG/X(6))
    KEIO=0
    IF(ABSB.LT.STOL) KEIO=1
    IF(ABSC.GT.STOL) KEIO=0
    IF(ABSD.GT.STOL) KEIO=0
    IF(ABSE.GT.STOL) KEIO=0
    IF(ABSF.GT.STOL) KEIO=0
    IF (ABSG.GT.STOL) KEIO=0
    IF(KEIO.EQ.1) GO TO 35
    I=I+1
    WRITE(6,42) I
 42 FORMAT(20X,14HITERATION NO.=,I2)
    IF(I.EQ.M) GO TO 35
    GO TO 55
 35 IF(I.EQ.M) GO TO 36
    GO TO 38
 36 WRITE(6,37)
 37 FORMAT(1X,34HOXYFNEW DID NOT CONVERGE WITHIN T*T)
    IF(X(1).LT.SI1) X(1)=SI1
    SI10=X(1)+2.*DS
    IF(X(2).LT.SI10) X(2)=SI10
    SI11=X(2)+2.*DS
    IF(X(3).LT.SI11) X(3)=SI11
    IF(X(4).LT.SI6) X(4)=SI6
```

```
      SI5=(0.5*PAI-GAMMA)*(1.-0.02)
      IF(X(5).LT.0.) GO TO 81
      IF(X(5).GT.SI5) X(5)=SI5
      GO TO 82
   81 IF(ABS(X(5)).GT.SI5) X(5)=-SI5
   82 CONTINUE
      IF (X(6).LE.0.) WRITE(6,1122)
 1122 FORMAT(2X,'----------X(5) BECAME LESS THAN ZERO ---------')
   88 RETURN
      END

**
```

```
      SUBROUTINE DFSIM1(ANS,NOF,XCA)
      DIMENSION XST(6)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON F_APAN,DELTA,DBAP,A_PA1,SAMM
      COMMON SIGMA,SBETA,XXM,ICPI,SARCO(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),CCC1,CLE,ERC,YMY,XM,ITERA,SXSID(6),SXSIOO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,KII(200),KJJ(200),XJX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
C     NOF     = 0  CALLED FROM F1INT.
C     NOF     = 1  CALLED FROM RMINT FOR REAL PART.
C     NOF     = 2  CALLED FROM RMINT FOR IMAG. PART.
C     NOF     = 3  CALLED FROM CAVITY DEFNE. AT F(3)
      IF (ICPI.EQ.0) GO TO 9
      DO 10 IG = 1,6
   10 XST(IG) = XSN(IG)
      GO TO 12
    9 DO 11 IH = 1,6
   11 XST(IH) = YXS(IH)
   12 CONTINUE
      IF(ITERA.EQ.1) GO TO 222
      GO TO 223
  222 DO 224 ILK = 1,LPM
  224 BETAN(ILK) = SBETA
  223 CONTINUE
      CSPACE = (1.+XST(1))/F_DAT(LPK)
      FSPACE = CSPACE/F_DAT(LPM-LPK)
      LPM3=LPM-3
      XBET = -1.+CSPACE+F_DAT(LPK-1)
      XSI1=-1.+CSPACE
      BE1 = BETAN(2)
      AP1 = (XSI1-XST(2))/((XSI1+1.)*(XST(1)-XSI1)*(XSI1-XST(3)))
      AP1S = SQRT(AP1)
      F3 = BE1*AP1S
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
      PLM = XSI1 -XX1
      P_M2 = PLM**2
      PLMA = PLM2+YY12
      PXSR = PLM/PLMA
      PXSI = YY1/PLMA
      IF(NOF.EQ.1) F3 = F3*PXSR
      IF(NOF.EQ.2) F3 = F3*PXSI
      IF(NOF.EQ.3) F3=F3/(XSI1-XCA)
      ANS4=0.
      DO 1 I = 2,LPM3,2
      F1 = F3
      SPACE = CSPACE
      IF (I.GE.LPK) GO TO 30
      XSI2 = -1.+SPACE*F_DAT(I)
      XSI3 = XSI2+SPACE
      GO TO 31
   30 SPACE  = FSPACE
      XSI2 = XBET+SPACE*F_DAT(I-LPK+1)
```

```
      XSI3 = XSI2+SPACE
   31 BE2 = BETAN(I+1)
      BE3 = BETAN(I+2)
      AP2 = (XSI2-XST(2))/((XSI2+1.)*(XST(1)-XSI2)*(XSI2-XST(3)))
      AP3 = (XSI3-XST(2))/((XSI3+1.)*(XST(1)-XSI3)*(XSI3-XST(3)))
      AP2S = SQRT(AP2)
      AP3S = SQRT(AP3)
      F2 = BE2*AP2S
      F3 = BE3*AP3S
      HA2 = XSI2-XX1
      HA22 = HA2**2
      HB = HA22+YY12
      HCR2 = HA2/HB
      HCI2 = YY1/HB
      HA3 = XSI3-XX1
      HA32 = HA3**2
      HD=HA32+YY12
      HCR3 = HA3/HD
      HCI3 = YY1/HD
      IF(NOF.EQ.1) F2 = F2*HCR2
      IF(NOF.EQ.1)  F3 = F3*HCR3
      IF (NOF.EQ.2)  F2 = F2*HCI2
      IF(NOF.EQ.2)  F3 = F3*HCI3
      IF (NOF.EQ.3)  F2 = F2/(XSI2-XCA)
      IF(NOF.EQ.3)  F3 = F3/(XSI3-XCA)
      FSUM = (F1+4.*F2+F3)*SPACE/3.
      ANSA = ANSA+FSUM
    1 CONTINUE
      SQ1 = SQRT((-1.-XST(2))/(-1.-XST(3)))
      SQ2 = SQRT(XST(1)+1.)
      SQ3 = SQRT((XST(1)-XST(2))/(XST(1)-XST(3)))
      ANT1 = BETAN(1)*2.*SQRT(SPACE)*SQ1/SQ2
      ANT2 = BETAN(LPM)*2.*SQRT(SPACE)*SQ3/SQ2
      APLA = -1.-XX1
      APLA2 = APLA**2
      APLB = XST(1)-XX1
      APLB2 = APLB**2
      IF(NOF.EQ.1) ANT1 = ANT1*APLA/(APLA2+YY12)
      IF (NOF.EQ.1) ANT2 = ANT2*APLB/(APLB2+YY12)
      IF (NOF.EQ.2 ) ANT1 = ANT1*YY1/(APLA2+YY12)
      IF (NOF.EQ.2) ANT2 = ANT2*YY1/(APLB2+YY12)
      IF (NOF.EQ.3) ANT1 = ANT1/(-1.-XCA)
      IF (NOF.EQ.3) ANT2 = ANT2/(XST(1)-XCA)
      ANS  = ANSA+ANT1+ANT2
      RETURN
      END

C
```

```
      SUBROUTINE DFSIM2(ANS2)
      DIMENSION X(3),XIT(3),YY(3),XITC(3),EXU(3),FCN3(3),XST(6)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAV(100),BBTAV2(100),BETAV2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFA1,GAMMA
      COMMON SIGMA,SBETA,KKK,ICPI,SARCD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSV(6),CCC1,CLE,ERC,YYY,XM,IFERA,SXSID(6),SXSIDD(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAV(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XRDJND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      DO 13 I6=1,6
   13 XST(I6)=YXS(I6)
      PAI=3.141592653
      JJ2=COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)/XST(6)
C                                          )AMMAG+)S(TSX(SDC/)AMMAG+1AFLA(SOC=2UJ
      KKKK=ALOG(JJ2)
      CSPACE=(1.+ XST(1))/FLOAT(LPK)
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(LPM-LPK)
      HFSPAC=0.5*FSPACE
      XBET=-1.+CSPACE*FLOAT(LPK-1)
      CDE=COS(DELTA)
      SDE=SIN(DELTA)
      GA=XST(1)-XST(4)*SDE
      GB=XST(4)*CDE
      PPP=CDE/(GA**2+GB**2)
      FCN3(3)=DSAP*PPP*XST(1)/(PAI*SQRT(1.+SIGMA))
      LPKI=LPM-LPK+1
      DO 1 IP=1,LPM
      IF(IP.EQ.1) GO TO 2
      HSPACE=HFSPAC
      SPACE=FSPACE
      IF(IP.GT.LPKI) GO TO 30
      X(1)=XST(1)-SPACE*FLOAT(IP-2)
      X(2)=X(1)-HSPACE
      X(3)=X(1)-SPACE
      GO TO 31
   30 HSPACE=HCSPAC
      SPACE=CSPACE
      X(1)=XBET-SPACE*FLOAT(IP-LPKI-1)
      X(2)=X(1)-HSPACE
      X(3)=X(1)-SPACE
   31 FCN3(1)=FCN3(3)
      NK=3
      IF(IP.EQ.LPM) NK=2
      DO 6 I=2,NK
      IF(IJ.GE.23) GO TO 3
      GO TO 7
    3 IF(I.EQ.2) XIT(2)=XITM(LPM-IP+1)
      IF(I.EQ.3) XIT(3)=XITN(LPM-IP+1)
      GO TO 5
    7 CONTINUE
      YY(I)=X(I)
C DFSIM3 CALCULATE G1 .
      CALL DFSIM3(YY(I),XITC(I),IP,I)
      XIT(I)=XITC(I)
```

```
      IF(IJ.EQ.18) GO TO 5
      GO TO 5
    6 IF(I.EQ.2) XITM(LPM-IP+1)=XIT(I)
      IF(I.EQ.3) XITN(LPM-IP+1)=XIT(I)
    5 CONTINUE
      EXJ(I)=EXP(-XIT(I))
      GC=X(I)-XST(4)*SDE
      GD=XST(4)*CDE
      PKA=GC**2+GD**2
      DWDX=DGAP*X(I)*CDE/(PXA*PAI)
      FCN3(I)=EXJ(I)*DWDX/JJ2
      IF(X(I).LE.0.) FCN3(I)=-FCN3(I)
    8 CONTINUE
C CHECK IF FCN3(I) IS ALWAYS POSITIVE.
      IF(IP.EQ.LPM) GO TO 20
      GO TO 21
   20 PPG=CDE/((-1.-XST(4)*SDE)**2+(XST(4)*CDE)**2)/JJ2
      FF3=DGAP*PPG/PAI
      FCN3(3)=FF3
   21 SUM=(FCN3(1)+FCN3(2)*4.+FCN3(3))*HSPACE/3.
      ANS2=ANS2+SUM
      IF(IJ.EQ.18) SARC(LPM-IP+1)=ANS2
      GO TO 1
    2 SARC(LPM)=0.
      ANS2=0.
    1 CONTINUE
C XITN(LPM)=G1 AT POINT B.
C XINT(1)=G1 AT POINT X=1.
      XITN(LPM)=CCC1-XKKK/PAI
      XITN(1)=0.
      RETURN
      END


$$
```

```
      SUBROUTINE DFSIM3(Y,CII,IP,I)
      DIMENSION XST(6),FX_S(100),FA(200)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSS2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,_PM,NS2
      COMMON AJ(110),ISHARP,NCHBY,BBTAN(110),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFA1,GAMMA
      COMMON SLOPA,SBETA,CCC4,ICPI,SARCJJ(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(6),SXSIOO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,_P(,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B23B,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
C     FOUR INTEGRALS TO BE EVALUATED BEFORE XI IS OBTAINED.
C     NOTE THAT PRIVIOUSLY ONLY ONE  SINGULAR INTEGRAL WAS
C     CALCULATED IN SCASCAD AND CASCADE.
C     SEE THE NOTE OF TO 3951 FOR FOUR INTEGRALS, OUT OF WHICH
C     TWO ARE OF SINGULAR TYPE.
      IF(ICPI.EQ.0) GO TO 9
      DO 11 ISI=1,6
   11 XST(ISI)=XSN(ISI)
      GO TO 12
    9 DO 13 JTJ=1,6
   13 XST(JTJ)=YXS(JTJ)
   12 PAI=3.141592653
C-----FIRS  I1-------
      IF (ITERA.EQ.1) GO TO 60
      GO TO 61
   60 CONTINUE
      DO 62 IZU = 1,LPM
      BETAN(IZU) = SBETA
      BETAM(IZU) = SBETA
   62 CONTINUE
   61 CONTINUE
      CSPACE=(1.+ XST(1))/FLOAT(_P()
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(_PM-LP()
      HFSPAC=0.5*FSPACE
      XBET=-1.+CSPACE*F_OAT(_P(-1)
      AB2=SQRT((ST(1)+1.)
      AB3=SQRT((1.+Y)*(XST(1)-Y))
      AB6 = SQRT((XST(3)-Y)/(XST(2)-Y))
      AB3 = AB3*AB6
      IJ2=_PM-IP+1
      IJ3=1
      IF(I.EQ.3) IJ3=_PM-IP+1
      IF(I.EQ.0) IJ3=IP
      BEC=BETAN(IJ3)
      IF(I.EQ.2) BEC=BETAM(IJ2)
      FAA=BEC/AB3
      _PM1=_PM-1
      DO 1 IW=2,_PM1
      SPACE=CSPACE
      IF(IW.GT._P() GO TO 45
      XSK=-1.+SPACE*FLOAT(IW-1)
      GO TO 46
   45 SPACE=FSPACE
      XSK=XBET+ SPACE*FLOAT(IW-LP()
   46 IF(I.EQ.2) GO TO 5
```

```
      IF(IW.EQ.IU3) GO TO 1
    5 FS=SQRT((1.+XSK)*(XST(1)-XSK))
      FSA1 = SQRT((XST(3)-XSK)/(XST(2)-XSK))
      FS = FS*FSA1
      FA(IW)=(BETAN(IW)/FS-FAA)/(XSK-Y)
    1 CONTINUE
      IF(I.EQ.2) GO TO 30
      XP1=-1.*HOSPAC
      XP2=XP1+CSPACE
      XP4=XST(1)-HFSPAC
      XP3=XP4-FSPACE
      FS1=BETAM(1)/ SQRT((1.+XP1)*(XST(1)-XP1))
      FS2=BETAM(2)/ SQRT((1.+XP2)*(XST(1)-XP2))
      FS3=BETAM(LPM-2)/ SQRT((1.+XP3)*(XST(1)-XP3))
      FS4=BETAM(LPM-1)/ SQRT((1.+XP4)*(XST(1)-XP4))
      FSA1 = SQRT((XST(2)-XP1)/(XST(3)-XP1))
      FSA2 = SQRT((XST(2)-XP2)/(XST(3)-XP2))
      FSA3 = SQRT((XST(2)-XP3)/(XST(3)-XP3))
      FSA4 = SQRT((XST(2)-XP4)/(XST(3)-XP4))
      FS1 = FS1*FSA1
      FS2 = FS2*FSA2
      FS3 = FS3*FSA3
      FS4 = FS4*FSA4
      FP1=(FS1-FAA)/(XP1-Y)
      FP2=(FS2-FAA)/(XP2-Y)
      FP3=(FS3-FAA)/(XP3-Y)
      FP4=(FS4-FAA)/(XP4-Y)
      IF(IU3.EQ.2) GO TO 21
      IF(IU3.EQ.LPM1) GO TO 22
      IF(IU3.EQ.LPK) GO TO 51
      FA(IU3)=0.5*(FA(IU3-1)+FA(IU3+1))
      GO TO 30
   51 BETO=2.*BETAN(LPK)-BETAN(LPK+1)
      XOA=XBET-FSPACE
      FPW=BETO/SQRT((1.+XOA)*(XST(1)-XOA))
      FPWA = SQRT((XST(2)-XOA)/(XST(3)-XOA))
      FPW=FPWA*FPW
      FLPK=(FPW-FAA)/(XOA-Y)
      FA(IU3)=0.5*(FA(IU3+1)+FLPK)
      GO TO 30
   21 FA(IU3)=(FP1+FP2)/2.
      GO TO 30
   22 FA(IU3)=(FP3+FP4)/2.
   30 XI=0.
      LPM3=LPM-3
      SPACE=CSPACE
      DO 15 JA=2,LPM3,2
      IF(JA.GE.LPK) SPACE=FSPACE
   15 XI=XI+(FA(JA)+4.*FA(JA+1)+FA(JA+2))*SPACE/3.
      IF(I.EQ.2) GO TO 35
      XI23=0.5*HCSPAC*(FP1+FA(2))+(FA(LPM-1)+FP4) *0.5*HFSPAC
      XXI=41.
      XJ=39
      LPMA=LPM-5
      IF(IU3.GE.LPMA) XXI=201.
      IF(IU3.GE.LPM4) XJ=139
      BDZ=(BETAN(1)-BETAN(1))/XXI
      BDY=(BETAN(LPM)-BETAN(LPM1))/XXI
      HFF=HFSPAC/XXI
      HFH=HCSPAC/XXI
```

```
      FT3=FP1
      FJ3=FP4
      XI4=0.
      XI1=0.
      DO 202 IT4=1,(J-2
      FT1=FT3
      FJ1=FJ3
      XM2=XST(1)-HFSPAC+HFF*FLOAT(IT4)
      XM3=XM2+HFF
      XT2=-1.+HCSPAC-HF4*FLOAT(IT4)
      XT3=XT2-HFH
      BETA2=BETAM(LPM1)+BOY*FLOAT(IT4)
      BETA3=BETA2+BOY
      BETT2=BETAM(1)-BOZ*FLOAT(IT4)
      BETT3=BETT2-BOZ
      FS2=BETA2/SQRT((1.+XM2)*(XST(1)-XM2))
      FS3=BETA3/SQRT((1.+XM3)*(XST(1)-XM3))
      FV2=BETT2/SQRT((1.+XT2)*(XST(1)-XT2))
      FV3=BETT3/SQRT((1.+XT3)*(XST(1)-XT3))
      FS2A = SQRT((XST(2)-XM2)/(XST(3)-XM2))
      FS3A = SQRT((XST(2)-XM3)/(XST(3)-XM3))
      FV2A = SQRT((XST(2)-XT2)/(XST(3)-XT2))
      FV3A = SQRT((XST(2)-XT3)/(XST(3)-XT3))
      FS2 = FS2*FS2A
      FS3 = FS3*FS3A
      FV2 = FV2*FV2A
      FV3 = FV3*FV3A
      FJ2=(FS2-FAA)/(XM2-Y)
      FJ3=(FS3-FAA)/(XM3-Y)
      FT2=(FV2-FAA)/(XT2-Y)
      FT3=(FV3-FAA)/(XT3-Y)
      XI4=XI4+HFF*(FJ1+FJ2*4.+FJ3)/3.
  202 XI1=XI1+HF4*(FT1+FT2*4.+FT3)/3.
      XA4=BETAN(LPM)*2.*SQRT(HFF)/(AB2*(XST(1)-Y))
      XA4A = SQRT((XST(2)-XST(1))/(XST(3)-XST(1)))
      XA4 = XA4*XA4A
      XI4=XI4+XA4
      XA1=BETAN(1)*2.*SQRT(HF4)/(AB2*(-1.-Y))
      XA1A = SQRT((XST(2)+1.)/(XST(3)+1.))
      XA1 = XA1*XA1A
      XI1=XI1+XA1
      XI=(XI+XI23+XI1+XI4)*AB3/PAI
      XI=XI+BEC*ALOG((XST(1)-Y-HFF)/(1.+Y-HF4))/PAI
      XXI1=-XI
      GO TO 36
   35 XR1=-1.+0.5*HCSPAC
      XR2=XR1+HCSPAC
      XR4=XST(1)-0.5*HFSPAC
      XR3=XR4-HFSPAC
      FT1=0.5*(BETAN(1)+BETAM(1))/ SQRT((1.+XR1)*(XST(1)-XR1))
      FT2=0.5*(BETAM(1)+BETAN(2))/ SQRT((1.+XR2)*(XST(1)-XR2))
      FT3=0.5*(BETAN(LPM-1)+BETAM(LPM-1))/ SQRT((1.+XR3)*(XST(1)-XR3))
      FT4=0.5*(BETAM(LPM-1)+BETAN(LPM))/ SQRT((1.+XR4)*(XST(1)-XR4))
      FT1A = SQRT((XST(2)-XR1)/(XST(3)-XR1))
      FT2A = SQRT((XST(2)-XR2)/(XST(3)-XR2))
      FT3A = SQRT((XST(2)-XR3)/(XST(3)-XR3))
      FT4A = SQRT((XST(2)-XR4)/(XST(3)-XR4))
      FT1 = FT1*FT1A
      FT2 = FT2*FT2A
      FT3 = FT3*FT3A
```

```
      XIB=2.*SQRT(HSP61)*BETAN(1)/(AB2*(-1.-Y))
      XIBA = SQRT((XST(2)+1)/(XST(3)+1.))
      XIB = XIB*XIBA
      XI1=XI1+XIB
      XI=(XI+XI1+XI23+XI4)*AB3/PAI
      XI=XI+BEC*ALOG((XST(1)-Y-HSP6)/(1.+Y-HSP61))/PAI
      XXI1=-XI
   35 CONTINUE
C-------I2-----------
C----------IF Y IS LESS THAN ZERO, THIS IS A
C-----REGULAR INTEGRAL, WHILE Y .GE. 0, THIS IS A
C-----SINGULAR INTEGRAL.
C     BUT THIS IS TREATED AS A SINGULAR INTEGRAL ANYWAY
      ISIC=3
      XCA=Y
      CALL IC2(SR,SM,XCA,ISIC)
      XXI2=SR
      ARGL=(XST(1)      -Y)/Y
      IF (ARGL.LT.0.) ARGL=-ARGL
      XXI2=XXI2+AB3+ALOG(ARGL)
      XXI2=-XXI2
C-----I3----------
C     USE CHEBYSHEV-GAUSS QUADRATURE.
C     AJ(I) ARE ALREADY CALCULATED IN SUBROUTINE F1INTL
C     AND PASSED ONTO HERE BY COMMON STATEMENT.
      XXI3 = 0.
      BPC5 = (XST(1)+XST(2))*.5
      CMB5 = (XST(2)-XST(1))*.5
      A31 = (BPC5+1.)/CMB5
      A32 = (-BPC5+XST(3))/CMB5
      DO 120 ISJM = 1,NCHBY
      HA1 = 1.-AJ(ISJM)
      HA2 = (AJ(ISJM)+A31)*(A32-AJ(ISJM))
      SHA2 = SQRT(HA2)
      F3I3 = HA1/SHA2
      F3AI3 = CMB5*AJ(ISJM)+BPC5-Y
  120 XXI3 = XXI3+F3I3/F3AI3
      XXI3 = XXI3*PAI/NCHBY
      JJ22 = COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)/XST(6)
      HX3 = CCC1-ALOG(UU22)/PAI
      XXI3 = XXI3*AB3*HX3
C-----I4----------
C     USE CHEBYSHEV-GAUSS QUADRATURE FORMULA---
C-----BBETAN2(I) ARE ALREADY CALCULATED IN
C     SUBROUTINE F1INTL AND PASSED ONTO HERE BY
C     COMMON STATEMENT.
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      XXI4 = 0.
      DO 130 ISJM = 1,NCHBY
      RAX = (BBTAN2(ISJM)+PAI)*(1.+AJ(ISJM))
      RBX = (AJ(ISJM)+A41)*(AJ(ISJM)+A42)
      SRBX = SQRT(RBX)
      RCX = RAX/SRBX
      RDX = FMC5*AJ(ISJM)+FPC5-Y
  130 XXI4 = XXI4 + RCX/RDX
      XXI4 = XXI4*PAI/NCHBY
      XXI4 = -XXI4*AB3/PAI
```

```
      FT4 = FT4+FT4A
      FR1=(FT1-FAA)/(XR1-Y)
      FR2=(FT2-FAA)/(XR2-Y)
      FR3=(FT3-FAA)/(XR3-Y)
      FR4=(FT4-FAA)/(XR4-Y)
      XIP1=0.5*HCSPAC*(FR1+FR2)+0.5*HFSPAC*(FR3+FR4)
      XIP2=0.25*HCSPAC*(FR2+FA(2))+0.25*HFSPAC*(FA(LPM-1)+FR3)
      XI23=XIP1+XIP2
      XMI=21.
      XMI2=42.
      MU=21
      M2=MU-2
      LPMA=LPM-5
      IF(IU2.GE.LPMA) XMI=101.
      IF(IJ2.GE.LPMA) XMI2=202.
      IF(IU2.GE.LPMA) MU=101
      IF(IJ2.GE.LPMA) M2=MJ-2
      BETY=(BETAN(LPM)-BETAM(LPM-1))/XMI2
      BESS=0.5*(BETAN(LPM)+BETAM(LPM-1))
      HSP6=0.5*HFSPAC/XMI
      FQ3=FR4
      BETY1=(BETAM(1)-BETAN(1))/XMI2
      BESS1=0.5*(BETAM(1)+BETAN(1))
      HSP61=0.5*HCSPAC/XMI
      FQ31=FR1
      XI1=0.
      XI4=0.
      DO 129 IL=1,M2,2
      FQ1=FQ3
      FQ11=FQ31
      X2=XST(1)-HSP6*FLOAT(MJ-IL)
      X3=X2+HSP6
      X21=-1.+HSP61*FLOAT(MJ-IL)
      X31=X21-HSP61
      BETA2=BESS+BETY*FLOAT(IL)
      BETA3=BESS+BETY*FLOAT(IL+1)
      BETA21=BESS1-BETY1*FLOAT(IL)
      BETA31=BETA21-BETY1
      FJ21=BETA21/ SQRT((1.+X21)*(XST(1)-X21))
      FJ31=BETA31/ SQRT((1.+X31)*(XST(1)-X31))
      FJ21A = SQRT((XST(2)-X21)/(XST(3)-X21))
      FJ31A = SQRT((XST(2)-X31)/(XST(3)-X31))
      FJ21 = FJ21*FJ21A
      FJ31 = FJ31*FJ31A
      FQ21=(FJ21-FAA)/(X21-Y)
      FQ31=(FJ31-FAA)/(X31-Y)
      FJ2=BETA2/ SQRT((1.+X2)*(XST(1)-X2))
      FJ3=BETA3/ SQRT((1.+X3)*(XST(1)-X3))
      FJ2A = SQRT((XST(2)-X2)/(XST(3)-X2))
      FJ3A = SQRT((XST(2)-X3)/(XST(3)-X3))
      FJ2 = FJ2*FJ2A
      FJ3 = FJ3*FJ3A
      FQ2=(FJ2-FAA)/(X2-Y)
      FQ3=(FJ3-FAA)/(X3-Y)
      XI1=XI1+HSP61*(FQ11+FQ21*4.+FQ31)/3.
  129 XI4=XI4+HSP6*(FQ1+4.*FQ2+FQ3)/3.
      XIA=2.*SQRT(HSP6)*BETAN(LPM)/(AB2*(XST(1)-Y))
      XIAA = SQRT((XST(2)-XST(1))/(XST(3)-XST(1)))
      XIA = XIA*XIAA
      XI4=XI4+XIA
```

```
      XXII = XXI1+XXI2+XXI3+XXI4
C                                                                     2=1TIR,I
C                                                                    03=2TIR,I
C                                                                    06=3TIR,I
C       ,I,4IXX, 3IXX,2IXX,1IXX )55,5(ETIR, )1TIR,I,QE,,I,DNA,81,QE,JI( FI
C        ,I,4IXX,3IXX,2IXX,1IXX )55,5(ETIR, )2TIR,I,QE,PI,DNA,,1,QE,JI( FI
C       ,I,4IXX,3IXX,2IXX,1IXX )55,5( ETIR, )3TIR,I,QE,,I,DNA,51,QE,JI( FI
C             ,X2,)X2,7,41E(4,,---ERA )4(F F3 4I,3I,2I,1I----,X01( TA4RC= 55
C                                                                    )4I,,=PI,A
      RETURN
      END

$$
```

```
      SUBROUTINE DFSIMS(ANS5)
      DIMENSION S2SR(101),S2KER(101),XST(6)
      COMMON YCOL,SBETA2
      COMMON XIT(200),XIN(200),ANSG2S(200),SARC2(200)
      COMMON CAVR(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AU(100),ISHAR,VCHBY,BETAV(100),BETAV2(100),BETAV2(100)
      COMMON FLAP,V,DELTA,DGAP,ALPHA1,GAMMA
      COMMON SIGMA,SBETA,XC,M,ICPI,SARCOD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(6),SXSIOO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A244,B288,C2CC
      COMMON AAAA,BBBB,CCCC,A5,B5,C5,D5,TGAUS(100),WGAUS(100),NGAUS
      PAI=3.141592654
C     THIS SUBROUTINE CALLED FROM DXFNE.
C     USE SIMPSONS RULE.
      DO 1 IMO = 1,6
    1 XST(IMO) = YXS(IMO)
      CDE = COS(DELTA)
      SDE = SIN(DELTA)
C  NS2 SHOULD HAVE A FACTOR OF 4.
C NS2=LPM*LP*2
      NS21 = NS2+1
      NS2A = NS2-1
      S2GAP = (XST(3)-XST(2))/NS2
      JJ2 = COS(ALPHA1+GAMMA)/COS(XST(5)+GAMMA)/XST(5)
C                                  )AMMAS+)5(TSX(SOC/)AMMAS+1AFLA(SOC = 2UJ
      DO 2 IS2 = 1,NS21
      XS2 = XST(2)+S2GAP*(IS2-1)
      XCO = XS2*CDE
      XMAS = XS2-XST(4)*SDE
      XMAS2 = XMAS**2
      ASD = XST(4)*CDE
      ASD2 = ASD**2
      DWDX = DGAP*XCO/((XMAS2+ASD2)*PAI)
      IF (IS2.EQ.1) GO TO 3
      IF (IS2.EQ.NS21) GO TO 4
      CALL G2 (XS2,ANSG2,IS2)
C     G2 CALCULATES G2 WITH XSI GIVEN.
      EG2 = EXP(-ANSG2)
      IF(IJ.EQ.27) ANSG2S(IS2)=ANSG2
      S2KER(IS2) = EG2*DWDX/JJ2
      GO TO 2
    3 CONTINUE
      S2KER(1) = DWDX/SQRT(1.+SIGMA)
      ANSG2S(IS2)=ALOG(SQRT(1.+SIGMA)/JJ2)
      GO TO 2
    4 CONTINUE
      S2KER(NS21) = DWDX/JJ2
      ANSG2S(IS2)=0.
    2 CONTINUE
      S2SR(1) = 0.
      DO 10 JS2 = 1,NS2A,2
   10 S2SR(JS2+2) = S2SR(JS2)
     1+(S2KER(JS2)+4.*S2KER(JS2+1)+S2KER(JS2+2))*S2GAP/3.
      IF(IJ.NE.27) GO TO 40
      SARC2(1)=0.
      DO 50 ISARC=2,NS2,2
   50 S2SR(ISARC)=.5*(S2SR(ISARC-1)+S2SR(ISARC+1))
```

```
      DO 30 ISARC=1,NS21
   30 SARC2(ISARC)=S2SR(ISARC)
   40 CONTINUE
      ANS5 = S2SR(NS21)
      RETURN
      END
```

```
      SUBROUTINE IC2(SR,SM,XCA,ISIC)
      DIMENSION XXER1(100),XXER2(100),XST(6)
      COMMON ICCC,SBETA2
      COMMON AIT1(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHAPE,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFA1,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOO(513)
      COMMON IOJ,XA,XB,XC,FANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(6),SXSIOO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A5,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      DO 1 IPN = 1,6
    1 XST(IPN) = FXS(IPN)
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
C     ISIC = 0 FOR RMINF
C          = 1 IN CAVITY OF OFSIMB FOR F(5) AND IN CAVITY.
C            2 CALLED FROM FLINT. FOR F(1).
C            3 FOR I2 OF F(4).
      SR=0.
      SM=0.
      BH=XST(1)*.5
      BHMC=BH-XST(2)
      BHP1=BH+1.
      BHMF=BH-XST(3)
      B11=BHMC/BH
      B12=BHP1/BH
      B13=BHMF/BH
      IF(ISIC.NE.3) GO TO 20
      AP1=(XCA+1.)*(XST(1)-XCA)*(XCA-XST(3))
      AP2=XCA-XST(2)
      AP3=SQRT(AP1/AP2)
   20 CONTINUE
      DO 7 ISUM=1,NCHBY
      RA=(AJ(ISUM)+B11) *(AJ(ISUM)+1.)
      RB=(AJ(ISUM)+B12)*(AJ(ISUM)+B13)
      SAB=SQRT(RA/RB)
      SAC=BH*SQRT(1.-AJ(ISUM)**2)/SAB
      XSIP=BH*AJ(ISUM)+BH
      XPXP=(SIP-XX1
      XPXP2=XPXP**2
      RV2=XPXP2+YY12
      RQR=XPXP/RV2
      RQI=YY1/RV2
      IF(ISIC.EQ.1) RQR=1./(XSIP-XCA)
      IF(ISIC.EQ.2) RQR=1.
      IF(ISIC.EQ.3) RQR=(1.-SAC/AP3)/( XSIP-XCA)
      SR=SR+SAB*RQR
    7 SM=SM+SAB*RQI
      PAI=3.141592654
      SR=SR*PAI/NCHBY
      SM=SM*PAI/NCHBY
      RETURN
      END
```

```
      SUBROUTINE F1INTL(YINT,KCTRL)
      DIMENSION XST(6),RJB(100)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSS2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),SBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFAI,GAMMI
      COMMON SIGMA,SBETA,XXM,ICPI,SARCCD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(6),SXSIOO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XCX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
C     SUBROUTINE F1INTL CALCULATES THE INTEGRALS IN F(1)
C     ISHARP = 0 FOR SHARP L.E.FOILS.
C     ISHARP = 1 FOR ROUNDED L.E.FOILS.
C     IF FOILS HAVE ROUNDED L.E.S CHEBYSHEV-GAUSS
C     QUADRATUE
C     QUADRATURE FORMULA CAN NOT BE USED.  SINCE BETA
C     IS NOT A SMOOTH FUNCTION.
C     NCHBY = NUMBER OF CHEBYSHEV-GAUSS QUADRATURE CONTROL POINTS.
      PAI = 3.141592654
      IF(ICPI.EQ.0) GO TO 9
      DO 70 I2 = 1,6
   70 XST(I2) = XSN(I2)
      GO TO 12
    9 DO 11 I4 = 1,6
   11 XST(I4) = YXS(I4)
   12 CONTINUE
    5 DN1 = (XST(1)+1.)*.5
      DN2 = (XST(1)-1.)*.5
      A11 = (DN2-XST(2))/DN1
      A12 = (DN2-XST(3))/DN1
      BC5 = (XST(1)+XST(2))*.5
      CMB5=(XST(2)-XST(1))*.5
      A31 = (BC5+1.)/CMB5
      A32 = (-BC5+XST(3))/CMB5
      FCA5 = (XST(3)-XST(2))*.5
      FC15 = (XST(3)+XST(2))*.5
      A41 = (FC15+1.)/FCA5
      A42 = (FC15-XST(1))/FCA5
      SPACE2 = (XST(3)-XST(2))/LPMM
C     READ LPMM FOR THE SECOND ARC.
      IF(KCTRL.GE.2) GO TO 100
      IF(IJ.GE.2) GO TO 100
      CSPACE = (1.+XST(1))/FLOAT(LPK)
      FSPACE = CSPACE/FLOAT(LPM-LPK)
      ICM = 1
      XCHCK = -1.
      SPACE=CSPACE
      DO 20 ICHBY=1,NCHBY
      NCH=NCHBY-ICHBY+1
      AJ(ICHBY)=COS((2*NCH-1)*PAI/(2*NCHBY))
      XXSI=DN1*AJ(ICHBY)+DN2
      IF(ITERA.EQ.1) GO TO 488
   22 IF(XCHCK.GE.XXSI) GO TO 21
      IF(ICM.GE.LPK) SPACE = FSPACE
      XCHCK = XCHCK+SPACE
      ICM = ICM+1
```

```
      GO TO 22
C  <<SI EXISTS BT. XSI(IOM-1) AND XSI(IOM)
   21 CONTINUE
      IOMA = IOM-1
      BBTAN(ICHBY) = BETAN(IOM)+(BETAN(IOM)-BETAN(IOMA))
     X*(XKSI-XCHCK)/SPACE
C     BBTAN IS USED FOR CHEBYCHEV-GAUSS INSTEAD OF BETAN.
      GO TO 20
  888 BBTAN(ICHBY) = SBETA
C BETAN FOR ITERA.EQ.1 IS SPECIFIED IN DFSIM1.
   20 CONTINUE
  100 CONTINUE
      IF(<CTRL.E..4) GO TO 4
      IF (<CTRL.EQ.3) GO TO 3
      IF (<CTRL.EQ.2) GO TO 2
      IF (ISHARP.EQ.1) GO TO 10
      YINT  = 0.
      DO 110 ISUM = 1,NCHBY
      ABC = (AJ(ISUM)+A11)/(AJ(ISUM)+A12)
  110 YINT  = YINT +BBTAN(ISUM)*SQRT(ABC)
      YINT = YINT*PAI/NCHBY
      GO TO 1000
   10 CONTINUE
C  THIS IS THE CASE OF HANDLING RADED L. E. .
      NOF = 0
      XCA = 0.
      CALL DFSIM1(YINT,NOF,XCA)
C     XCA IS DUMMY, ONLY USED FOR F(5) INDEFINE.
      GO TO 1000
    2 CONTINUE
      XCA=0.
C XCA IS DUMMY.
      ISIC=2
      CALL IC2(SR,SM,XCA,ISIC)
      YINT=SR
      GO TO 1000
    3 CONTINUE
C-----INTEGRAL FOR I3.
C  AJ(N) IS CALCULATED AND STORED
      YINT = 0.
      DO 120 ISUM = 1,NCHBY
      A31 = 1.-AJ(ISUM)
      A32 = (AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SQA32 = SQRT(A32)
      ABC = A31/SQA32
  120 YINT = YINT+ABC
      YINT = YINT*PAI/NCHBY
      GO TO 1000
C-----INTEGRAL FOR I4
C     SINCE BETA(N) BTWN TOT AND TFT ARE
C     EXPECTED TO BE ALWAYS SMOOTH, USE GAUSS-
C     CHEBYSHEV QUADRATURE FORMULA.
C     AJ(N) IS ALREADY CALCULATED.
C     IF THIS IS THE FIRST CASE FOR BETAN2,
C     USE A CONSTANT FOR BETAN2.
C     BBTAN2 IS USED FOR CHEVY-GAUSS INSTEAD OF BETAN2.
    4 CONTINUE
      IF(ITERA.GE.2) GO TO 150
      IF(IJ.GE.2) GO TO 131
C  SBETA2 MUST BE READ FOR THE FIRST RUN.
```

```
      DO 180 ICHBY = 1,NCHBY
  180 BBTAN2 (ICHBY) = SBETA2
      NS21=NS2+1
      DO 185 IOC=1,NS21
  185 BETAN2(IOC)=SBETA2
      GO TO 181
  150 CONTINUE
      IF(IJ.GE.2) GO TO 181
      IDMM = 1
      XCHCK = XST(2)
      DO 170 ICHBY = 1,NCHBY
      XXSI = FCA5*AJ(ICHBY)+FC15
  152 IF(XCHCK.GE.XXSI) GO TO 151
      XCHCK = XCHCK + SPACE2
      IDMM = IDMM+1
      GO TO 152
  151 CONTINUE
      IDMMA = IDMM-1
      BBTAN2(ICHBY) = BETAN2(IDMM)
     1+(BETAN2(IDMM)-BETAN2(IDMMA))*(XXSI-XCHCK)/SPACE2
      ILM=ICHBY
      XXSI = FCA5*AJ(ILM  )+FC15
      WRITE(6,250) ILM,BBTAN2(ILM),XXSI
  250 FORMAT(15X,*I=*,I3,2X,*BBTAN2=*,E14.7,2X,*XXSI=*,E14.7)
  170 CONTINUE
  181 CONTINUE
      YINT = 0.
      DO 190 ISJM = 1,NCHBY
      AB1 = (BBTAN2(ISJM)+PAI)*(1.+AJ(ISJ4))
      AB2 = (AJ(ISJM)+A41)*(AJ(ISJM)+A42)
      SQAB2 = SQRT(AB2)
  190 YINT = YINT + AB1/SQAB2
      YINT = YINT*PAI/NCHBY
 1000 CONTINUE
      RETURN
      END

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```

```
      SUBROUTINE CAVITY (XCC,YCC)
C THIS SUBROUTINE IS CALLED FROM DEFINE, FOR F(5).
      DIMENSION CXEX(100),CXEY(100),ANSI1(100),SRI2(100),SIC3I3(100)
      DIMENSION SIC4I4(100),XST(6)
      DIMENSION CAVXX(100),CAVYY(100)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSS2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALPAI,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),CCC1,CLE,ERC,YYY,XM,ITERA,SXSID(6),SXSIDD(6),YYS(6)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LP(,XII(200),XJJ(200),XCX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AS,BB,CB,DE,TGAUS(100),WGAUS(100),NGAUS
C XCCC IS THE CAVITY END POINT CALCULATED IN SUB. CAVITY.
      SQSM = SQRT(1.+SIGMA)
      CDEL = COS(DELTA)
      SDEL = SIN(DELTA)
      PAI = 3.141592654
      DO 1 LDA = 1,6
    1 XST(LDA) = YXS(LDA)
      NCAV=80
      NCAV1=NCAV+1
      CAVS = (XST(2)-XST(1))/NCAV
C     LEAVE THE LAST POINT OF XSI = 0 SINCE THERE IS A
C     , SINGULARITY FOR SINGLE SPIRAL VORTEX MODEL.
      DO 2 KLM = 1,NCAV1
      XCA = XST(1) +CAVS* (KLM-1)
C     REAL PART OF OMEGA = BETA* PAI.
      IF (KLM.EQ.1) GO TO 3
      IF(KLM.EQ.NCAV1) GO TO 10
C-----IC1(XSI) CALCULATION, CALLING DFSIM1.
      IF (IJ.GE.34) GO TO 75
      NDF = 3
      CALL DFSIM1(ANS,NDF,XCA)
C     ANS IS A SOLUTION FOR IC1(XCI), XCI IS IDENTICAL TO XCA.
      IF (IJ.EQ.27) ANSI1(KLM) = ANS
      GO TO 76
   75 ANS = ANSI1(KLM)
   76 CONTINUE
C---- IC2(XSI) CALCULATION.
      IF(IJ.GE.34) GO TO 77
      ISIC = 1
      CALL IC2(SR,SM,XCA,ISIC)
C     ONLY SR IS UTILIZED-- SM IS FOR PRINT.
      IF (IJ.EQ.27) SRI2(KLM) = SR
      GO TO 78
   77 SR = SRI2(KLM)
   78 CONTINUE
C-----IC3 (XSI) CALCULATION-- USE CHEBYSHEV-GAUSS
C     QUADRATURE FORMULA.
      BPC5 = (XST(1)+XST(2))*.5
      CMB5 = (XST(2)-XST(1))*.5
      A31 = (BPC5+1.)/CMB5
      A32 = (-BPC5+XST(3))/CMB5
      E(1 = XCA-XST(2)
      E(2 = (XCA+1.)*(XCA-(ST(1))*((XCA-(ST(3))
```

```
      EK3 = SQRT(EK1/EK2)
      EF3B = CMB5*EK3
      IF (IJ.GE.34) GO TO 30
      SIC3 = 0.
      DO 5 ISUM = 1,NCHBY
      EJ1=(AJ(ISJM)+A31)*(A32-AJ(ISJM))
      SEJ1 = SQRT(EJ1)
      EF3 = (1.-AJ(ISUM))/SEJ1
      EF3A = CMB5*AJ(ISJM)+BPC5-XCA
    5 SIC3 = SIC3+(EF3-EF3B*SQRT(1.-AJ(ISJM)**2))/EF3A
      SIC3 = SIC3*PAI/NCHBY
      SIC3 = SIC3+ALOG((XST(2)-XCA)/(XCA-XST(1)))*EK3
      IF(IJ.EQ.27) SIC3I3(KLM) = SIC3
      GO TO 31
   30 SIC3 = SIC3I3(KLM)
   31 CONTINUE
C-----IC4(XSI)----.
C     USE CHEBYSHEV-GAUSS QUADRATURE FORMULA
C        IN THE SAME MANNER AS THAT FOR I3 IN
C        CF3IM3.
      IF(IJ.GE.34) GO TO 32
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      SIC4 = 0.
      DO 7 ISJM= 1,NCHBY
      RA = (BETAN2(ISJM)+PAI)*(1.+AJ(ISJM))
      RB = (AJ(ISUM)+A41)*(AJ(ISJM)+A42)
      SRB = SQRT(RB)
      RC = RA/SRB
      RD = FMC5*AJ(ISJM)+FPC5-XCA
    7 SIC4 = SIC4+RC/RD
      SIC4 = SIC4*PAI/NCHBY
      IF(IJ.EQ.27) SIC4I4(KLM)= SIC4
      GO TO 33
   32 SIC4 = SIC4I4(KLM)
   33 CONTINUE
C  IC(XSI) = 1/EK3  ALREADY CALCULATED.
      CJC = COS(ALPAI+GAMMA)/COS(XST(5)+GAMMA)/XST(5)
      SC = (-ANS/PAI-SR*(CCC1-ALOG(JJ2)/PAI)*SIC3
     1-SIC4/PAI)/EK3
      GO TO 25
    3 GC = BETAB*PAI
      GO TO 25
   10 GC=BETAC*PAI
C BETAB AND BETAC( BODY ANGLES AT B AND C) MUST BE SPECIFIED IN COMMON.
   25 CONTINUE
      KKS = KCA*CDEL
      YYT = XCA-XST(4)*SDEL
      YYT2 = YYT**2
      XXU = XST(4)*CDEL
      XXU2 = XXJ**2
      XYB = YYT2+XXU2
      DWDX = DGAP*XXS/(XYB*PAI)
      CGC = COS(GC)
      SGC = SIN(GC)
      CFC = DWDX/SCGM
      CKEX(KLM) = CGC*CFC
      SKEY (KLM) = SGC*CFC
```

```
    2 CONTINUE
      CAVXX(1)=0.
      CAVYY(1)=0.
      DO 15 ICAV=3,NCAV1,2
      CAVXX(ICAV) = CAVXX(ICAV-2)+CAVS*(CKEX(ICAV-2)+4.*
     1CKEX(ICAV-1)+CKEX(ICAV))/3.
   15 CAVYY(ICAV) = CAVYY(ICAV-2)
     1+CAVS*(SKEY(ICAV-2)+4.*SKEY(ICAV-1)+SKEY(ICAV))/3.
      IF(IJ.EQ.27) GO TO 100
      GO TO 101
  100 DO 102 ICAV=1,NCAV1,2
      CAVX(ICAV)=CAVXX(ICAV)
  102 CAVY(ICAV)=CAVYY(ICAV)
      XCCC=CAVX(NCAV1)
      YCCC=CAVY(NCAV1)
  101 CONTINUE
      XCC=CAVXX(NCAV1)
      YCC=CAVYY(NCAV1)
      RETURN
      END
                                                                    PCA80WI
```

68

```
      SUBROUTINE G2 (XS2,AG2,IS2)
      DIMENSION    XST(6),XI21S(200),XI22S(200),XI23S(200),XI24S(200)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALPA1,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDJ,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSV(6),CCC1,CLE,ERC,YYY,XM,ITERA,SXSID(6),SXSIDD(6),YXS(6)
      COMMON FSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
C     THIS SUBROUTINE IS CALLED BY DFSIM5.
C     THIS SUBROUTINE CALCULATES FUNCTION G2(XS2) WHICH
C     INCLUDES I21(XS2) TO I24(XS2).
C     XS2 IS XSI- AG2 IS THE SOLUTION OF INTEGRALS.
      DO 1 IGP=1,6
    1 XST(IGP)=YXS(IGP)
      PAI = 3.141592654
      IF (IJ.GE.34) GO TO 100
C---I21(XSI)----.
C     THE SAME INTEGRATION AS THAT IN
C     SUBROUTINE CAVITY FOR GC(XSI)
      NDF = 3
      CALL DFSIM1(ANS,NDF,XS2)
      XI21 = ANS
      IF(IJ.EQ.27) XI21S(IS2) = XI21
C----I22(XSI)----.
C     USE THE SAME SUBROUTINE IC2 AS
C     USED IN CAVITY WITH ISIC=1.
      ISIC=1
      CALL IC2(SR,SM,XS2,ISIC)
      XI22 = SR
C     NOTE THAT SM IS DUMMY VARIABLE.
      IF(IJ.EQ.27) XI22S(IS2) = XI22
C----I23(XSI)----.
C     USE CHEBYCHEV-GAUSS QUADRATURE FORMULA
C       IN EXACTLY SIMILAR MANNER TO THAT IN
C         DFSIM3 FOR I3.
      XI23 = 0.
      BPC5 = (XST(1)+XST(2))*.5
      CM55 = (XST(2)-XST(1))*.5
      A31 = (BPC5 + 1.)/CM55
      A32 = (-BPC5 + XST(3))/CM55
      DO 2 ISUM = 1,NCHBY
      HA1 = 1.-AJ(ISUM)
      HA2 = (AJ(ISUM) + A31)*(A32-AJ(ISUM))
      SHA2 = SQRT(HA2)
      F3I3 = HA1/SHA2
      F3AI3 = CM55*AJ(ISUM)+BPC5-XS2
    2 XI23 = XI23+F3I3/F3AI3
      XI23 = XI23*PAI/NCHBY
      IF (IJ.EQ.27) XI23S(IS2) = XI23
C-----I24------.
C     USE CHEBYCHEV-GAUSS QUADRATURE
C        FORMULA BY ASSUMING THAT
C        THE KERNEL FCN. IS SMOOTH.
      HU = (XS2+1.)*(XS2-XST(1))*(XST(3)-XS2)
```

```
      HV = XS2-XST(2)
      HW = SQRT(HU/HV)
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      XI24 = 0.
      DO 10 ISUM = 1, NCHBY
      TPA1 = AJ(ISUM)+A41
      TPA2 = AJ(ISUM)+A42
      STP = SQRT(TPA1*TPA2)
      F4T = (BETAN2(ISUM)+PAI)*(1.+AJ(ISUM))/STP
C     BETAN2 IS CHEBY-GAUSS VERSION FOR BETA ON THE SECOND ARC.
      F4A = FMC5*AJ(ISUM)+FPC5-XS2
      ST2 = SQRT(1.-AJ(ISUM)**2)
      F4B = FMC5 *ST2*(BETAN2(IS2 )+PAI)/HW
   10 XI24 = XI24+(F4T-F4B)/F4A
      XI241 = XI24*PAI/NCHBY
C     BETAN2 IS USED FOR SIMPSONYS RULE.
      XLG = ALOG((XST(3)-(S2)/((S2-XST(2)))
C     IS2 IS TRANSFERRED THROUGH S2-ARGUMENT.
      XI242 = XLG*(BETAN2(IS2)+PAI)/HW
      XI24 = XI241+XI242
      IF(IU.EQ.27) XI24S(IS2) = XI24
      GO TO 101
  100 XI21 = XI21S(IS2)
      XI22 = XI22S(IS2)
      XI23 = XI23S(IS2)
      XI24 = XI24S(IS2)
  101 XS2A = -XI21/PAI-XI22
      XS2B = CCC1-ALOG(CCC5(A_FA1+SA444A)/C)S(XST(5)+SA444A) /XST(6))/PAI
C                 IAP/))A444G+)5(TSX(SOC/)AMMAG+1AF_A(SOC(GOLA-1CCC = B2SX
      XS2C = XS2B*XI23
      XS2D = -XI24/PAI
      AG2 = (XS2A+XS2C+XS2D)*HW
C           2SI,42IX,32IX,22IX,12IX )25,5(ETIR, )2.2E.2SI.DNA.72.2E.JI( FI
C          2SI,42IX,32IX,22IX,12IX )25,5(ETIRW )01.2E.2SI.DNA.72.GE.JI( FI
C          2SI,42IX,32IX,22IX,12IX )25,5(ETIRW )01.2E.2SI.DNA.72.GE.JI( FI
C               ,X2,)X2,7.41E(4,----ERA )5(F FO 4I,3I,2I,1I----*,XC1(TAMRCF 25
C                                                                  )4I,*=2SI* A
      RETURN
      END
```

```
      SUBROUTINE R4INT (SR,SM,MIQ)
      DIMENSION XST(6)
      COMMON YCCC,SBETA2
      COMMON XITN(200),XITN(200),ANSS2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAP,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFAI,GAMMA
      COMMON SIGMA,SBETA,KKM,ICPI,SARCOD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,KLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(6),SXSIOO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARC2(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XMDJND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      PAI = 3.141592654
      IF (ICPI.EQ.0) GO TO 10
      DO 12 IS = 1,6
   12 XST(IS) = XSN(IS)
      GO TO 11
   10 DO 1 IS = 1,6
    1 XST(IS) = YXS(IS)
   11 CONTINUE
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
      CB5 = (XST(2)-XST(1))*.5
      BC5 = (XST(1)+XST(2))*.5
      A31 = (BC5+1.)/CB5
      A32 = (-BC5+XST(3))/CB5
      BM15 = (XST(1)-1.)*.5
      BP15 = (XST(1)+1.)*.5
      A11 = (BM15-XST(2))/BP15
      A12 = (BM15-XST(3))/BP15
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      IF(MIQ.EQ.4) GO TO 4
      IF (MIQ.EQ.3) GO TO 3
      IF (MIQ.EQ.2) GO TO 2
C     AJ(I) ARE ALREADY CALCULATED IN SUBROUTINE
C           FFINTF AND STORED IN COMMON AREA.
      SR=0.
      SM=0.
      DO 20 ISUM = 1,NCHBY
      GX1 = 1.-AJ(ISUM)
      GY1 = (AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SGY1 = SQRT(GY1)
      FF3 = GX1/SGY1
      FX1 = CB5*AJ(ISUM)+BC5
      FX2 = FX1-XX1
      FX22=FX2**2
      FX3 = FX22+YY12
      FF31 = FX2/FX3
      FF32 = YY1/FX3
      SR = SR+FF3*FF31
   20 SM = SM+FF3*FF32
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
```

```
    2 CONTINUE
      IF (ISHARP.EQ.1) GO TO 100
C     ISHARP = 1 MEANS THAT THE FOIL HAS ROUNDED L.E.
C     SO THAT THE SIMPSONTS RULE IS USED.
C     ISHARP = 0 MEANS THAT THE FOIL HAS SHARP L.E.
C     SO THAT CHEBYSHEV GAUSS FORMULA CAN BE USED AS BELOW.
      SR = 0
      SM = 0
      DO 30 ISUM = 1,NCHBY
      ST11 = AJ(ISUM)+A11
      ST12 = AJ(ISUM)+A12
      FK1 = BBTAN(ISUM)*SQRT(ST11/ST12)
      UN1 = BP15*AJ(ISUM)+BM15-XX1
      UN12 = UN1**2
      UN13 = UN12+YY12
      FK11 = UN1/UN13
      FK12 = YY1/UN13
      SR = SR+FK1*FK11
   30 SM = SM+FK1*FK12
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
  100 CONTINUE
C     THIS IS THE CASE THAT THE FOIL HAS ROUNDED L.E.
      NOF = 1
      XCA = 0.
      CALL OFSIM1(SR,NOF,XCA)
C  (CA IS DUMMY----ONLY USED FOR F(5) IN DXFNEW.
      NOF=2
      CALL OFSIM1(SM,NOF,XCA)
      GO TO 1000
    3 CONTINUE
C     USE CHEBYSHEV-GAUSS FORMULA SINCE BETA
C     IN THIS REGION IS SMOOTH.
C     BBTAN2 (ISUM) ARE ALREADY CALCULATED AT POINT.
      SR = 0.
      SM = 0.
      DO 50 ISUM = 1,NCHBY
      PSL = (BBTAN2(ISUM)*PAI)*(1.+AJ(ISUM))
      PSM = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
      SQPSM = SQRT(PSM)
      FF4 = PSL/SQPSM
      PSN = FMC5*AJ(ISUM)+FPC5-XX1
      PSN2 = PSN**2
      FF41 = PSN/(PSN2+YY12)
      FF42 = YY1/(PSN2+YY12)
      SR = SR+FF4*FF41
      SM =SM+FF4*FF42
   50 CONTINUE
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
    4 CONTINUE
C     XCA IS DUMMY, ONLY USED FOR IC2 IN F(5)
      XCA = 0.
      ISIC = 0
C     SUBROUTINE IC2 IS ALSO USED IN F(5).
      CALL IC2(SR,SM,XCA,ISIC)
 1000 RETURN
      END
```

```
      SUBROUTINE SHAPE(X,Y,BETA,IS1I2)
      COMMON/FREECAV/XFREEC,YFREEC
      COMMON/UPPER/A2AAU,B2BBU,C2CCU,AAAAJ,BBBBU,CCCCJ,A8U,B8J,C8U,D8U
      COMMON/THICK/TH
      COMMON YCCC,SBETA2
      COMMON XII4(200),XITN(200),ANSS2S(200),SARC2(200)
      COMMON CAVC(100),CAVT(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALPAI,SAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),CCC1,CLE,ERC,YYY,XM,ITERA,SKSID(6),SXSIDD(6),YXS(6)
      COMMON PSIZ,LP,SARC(613),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TSAJS(100),WGAJS(100),NGAUS
      PAI =3.141592653
      X2=X**2
      X3=X**3
      XS=SQRT(X)
      X4=X**4
      XFREE2=XFREEC**2
      XFREE3=XFREEC**3
      XFREES=SQRT(XFREEC)
      XFREE4=XFREEC*XFREES
      X22=.2**2
      X23=.2**3
      X2S=SQRT(.2)
      X2H=.2*X2S
      X82=.8**2
      X83=.8**3
      X8S=SQRT(.8)
      X8H=X8S*.8

C WE MUST CHECK TO SEE IF WE ARE GOING TO CALCUATE THE TOP PART
C OR THE BOTTOM PART. IF TOP WE TRANSFER TO 2ND HALF OF ROUTINE.
C IS1I2 = 3 IS USED FOR CALCULATIONS OF UPPER FOIL PROFILE

      IF(IS1I2.EQ.1) GO TO 30
      IF (IS1I2.EQ.3) GO TO 30

      IF (X.LE.X22) GO TO 15
      IF (X.LE.X8) GO TO 20
      IF (X.GT.X8) GO TO 25

   15 Y=A2AA*X+B2BB*X2+C2CC*X3
      YDX=A2AA+B2BB*2.*X+C2CC*3.*X2
      BETA=ATAN(YDX)
      GO TO 60
   20 Y=AAAA*(4./3.*X+8./3.*XH-4.*X2)+BBBB*X+CCCC*XS
      YDX=AAAA*(4./3.+8./3.*1.5*XS-8.*X)+BBBB+.5*CCCC/XS
      BETA=ATAN(YDX)
      GO TO 60
   25 Y=A8+B8*X+C8*X2+D8*X3
      YDX=B8+2.*C8*X+3.*D8*X2
      BETA=ATAN(YDX)
      GO TO 60

C THIS 2ND HALF OF THE ROUTINE IS FOR CALCULATING THE UPPER HALF
```

```
   50 IF (IS1I2.EQ.3) GO TO 70
      IF (XFREEC.LE..2) GO TO 35
      IF (XFREEC..E..8) GO TO 50
      IF (XFREEC.GT..8) GO TO 55
   70 CONTINUE
      IF (X.LE..2) GO TO 35
      IF (X..E..8) GO TO 50
      IF (X.GT..8) GO TO 55

   35 R1=YFREEC-A2AAJ*XFREEC-B2BBJ*XFREE2-C2CCU*XFREE3
      IF (IS1I2.EQ.3) R1=0.
      IF (X.GT..2) GO TO 40
      Y=A2AAU*X+B2BBU*X2+C2CCU*X3+R1
      YDX=A2AAU+2.*B2BBJ*(+3.*C2CCJ*X2
      BETA=ATAN(YDX)-PAI
      GO TO 60
   40 Y2=A2AAJ*.2+B2BBJ*X22+C2CCJ*X23+R1
      R2=Y2-AAAAJ*(4./3.*.2+8./3.*X2+-4.*X22)-BBBBU*.2-CCCCU*X2S
      IF (IS1I2.EQ.3) R2=0.
      IF(X.GT..8) GO TO 45
      Y=AAAAJ*(4./3.*X+8./3.*X+-4.*X2)+BBBBJ*X+CCCCJ*XS+R2
      YDX=AAAAJ*(4./3.+8./3.*1.5*(S-6.*()+BBBBJ+.5*CCCCJ/XS
      BETA=ATAN(YDX)-PAI
      GO TO 60
   45 Y3=ABJ+BBU*.8+CBU*X82+DBU*X83+R2
      R3=Y3-ABU-BBU*.8-CBJ*X82-DBJ*X83
      IF (IS1I2.EQ.3) R3=0.
   45 Y=ABU+BBJ*X+CBJ*X2+DBJ*X3+R3
      YDX=BBJ+2.*CBJ*X+3.*DBJ*X2
      BETA =ATAN(YDX)-PAI
      GO TO 60
   55 R2=YFREEC-AAAAU*(4./3.*XFREEC+8./3.*XFREEH-4.*XFREES)-BBBBU*XFREEC
     1 -CCCCJ*XFREES
      IF (IS1I2.EQ.3) R2=0.
      IF (X.GT..8) GO TO 45
      Y=AAAAJ*(4./3.*X+8./3.*X+-4.*X2)+BBBBJ*X+CCCCJ*XS+R2
      YDX=AAAAU*(4./3.+8./3.*1.5*XS-8.*X)+BBBBU*.5*CCCCU/XS
      BETA=ATAN(YDX)-PAI
      GO TO 60
   55 R3=YFREEC-ABU-BBJ*XFREEC-CBJ*XFREE2-DBJ*XFREE3
      IF (IS1I2.EQ.3) R3=0.
      GO TO 46

   60 RETURN
      END

**
```

```
      SUBROUTINE ARCS2(S2,XC,YC)
      COMMON/FOIL_END/XXDD,YYDD
      COMMON/UPPER/A24AAJ,B23BBJ,C22CCJ,AAAAAJ,BBBBBJ,CCCCCJ,A8J,B8J,C8J,D8J
C  XXDD IS THE ENDPOINT OF THE UPPER FOIL OFFSET
      IF (XC.LE.0.) GO TO 10
      GO TO 11
   10 WRITE(6,12)
   12 FORMAT(10X,'------ STOP FOR XC LESS THAN ZERO, DONE AT ARCS2 -----')
      STOP
   11 CONTINUE
      CXDD=XXDD
      XHIGH=0.
      X_0=0.
      XINCRT=(CXDD-XC)/50.
      IF (XINCRT.LE.0.) XINCRT=-XINCRT
      IS112=1
      S2=0.
      DO 24 IINC=1,50
      X_0=XHIGH
      XHIGH=XLOW+XINCRT
      CALL ARCLEN(S,X_0,XHIGH,IS112)
   24 S2=S2+S
      RETURN
      END
```

```
      SUBROUTINE XCYC(XCB,YCB,CX,CY)
      COMMON/UPPER/A2AAJ,B2BBU,C2CCJ,AAAAJ,BBBBJ,CCCCJ,A8J,B8U,C8U,D8U
      XK=CX
      XK2=XK**2
      XK3=XK**3
      XK5=SQRT(XK)
      XKH=XK*XK5
      IP=0
      IF (CX.LE..2) GO TO 3
      IF (CX.LE..8) GO TO 4
      IF (CX.GT..8) GO TO 5
    3 F1=A2AAJ*XK+B2BBU*XK2+C2CCJ*XK3
      F2=A2AAJ+2.*B2BBJ*XK+3.*C2CCJ*XK2
      F3=XK-CX
      FXK=F1+(F3/F2-CY)
      D1=F2
      D2=(D1+F3*(2.*B2BBJ+6.*C2CCJ*XK))/D1**2
      DFXK=D1+D2
      DIV=FXK/DFXK
      XK=XK-DIV
      IP=IP+1
      Z=ABS(DIV/XK)
      IF((Z.LE..000001).OR.(IP.EQ.20)) GO TO 6
      GO TO 3
    4 F1=AAAAJ*(4./3.*XK+3./3.*XKH-4.*XK2)+BBBBJ*XK+CCCCJ*XK5
      F2=AAAAJ*(4./3.+6./3.*1.5*XK5-5.*XK)+BBBBJ+CCCCJ*.5/XK5
      F3=XK-CX
      FXK=F1+(F3/F2-CY)
      D1=F2
      D2=(D1-F3*(AAAAJ*(8./3.+1.5*.5/XK5-3.)-CCCCJ*.5*.5/XKH))/D1**2
      DFXK=D1+D2
      DIV=FXK/DFXK
      IP=IP+1
      Z=ABS(DIV/XK)
      IF((Z.LE..000001).OR.(IP.EQ.20)) GO TO 6
      GO TO 4
    5 F1=A8J+B8J*XK+C8J*XK2+D8J*XK3
      F2=B8J+2.*C8J*XK+3.*D8J*XK2
      F3=XK-CX
      FXK=F1+(F3/F2-CY)
      D1=F2
      D2=(D1-F3*(2.*C8J+6.*D8J*XK))/D1**2
      DFXK=D1+D2
      DIV=F  (/DFXK
      XK=X  -DIV
      IP=IP+1
      Z=ABS(DIV/XK)
      IF((Z.LE..000001).OR.(IP.EQ.20)) GO TO 6
      GO TO 5
    6 XCB=XK
      IF (CX.LE..2) YCB=A2AAJ*XK+B2BBJ*XK2+C2CCJ*XK3
      IF(CX.LE..8) YCB=AAAAJ*(4./3.*XK+8./3.*XKH-4.*XK2)+BBBBJ*XK
     ( +CCCCJ*XK5
      IF (CX.GT..8) YCB=A8J+B8J*XK+C8J*XK2+D8J*XK3
      RETURN
      END
```

```
      SUBROUTINE FC2(T,F,X_,XH,ISII2)
      COMMON/UPPER/A2AAU,B2BBU,C2CCU,AAAAU,BBBBU,CCCCU,A8U,B8U,C8U,D8U
      COMMON YCCC,SBETA2
      COMMON CIFM(200),CIFN(200),ANSS2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AU(100),ISMARP,NCMBY,BBTAN(100),BETAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALPA1,GAMMA
      COMMON SIGMA,SBETA,XX4,ICPI,SARCDD(513)
      COMMON IOU_,XA,XB,XC,TANG,EP,YC,YR,UBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(6),SXSIOO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCD(513),_PM,DE
      COMMON BETAN(513),BETAM(513),IU,LPK,XII(200),XJJ(200),XDX
      COMMON XRDJND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TBAJS(100),WGAUS(100),NGAUS
      IICONT=1
      XP=(XH-XL)*T*.5+(XH+X_)*.5
      SXP=SQRT(XP)
      XP2=XP**2
      IF(XP.GE..8) GO TO 1
      IF(XP._E..2.AND.IICONT.EQ.1) GO TO 4
      IF(XP.LE..2)  GO TO 3
      P1=(4./3.+4.*SXP-4.*XP)*AAAA
      P2=BBBB
      P3=.5*CCCC/SXP
      IF (IS1I2.EQ.1) P1=(4./3.+4.*SXP-4.*XP)*AAAAU
      IF (IS1I2.EQ.1) P2=BBBBU
      IF (IS1I2.EQ.1) P3=.5*CCCCU/SXP
      GO TO 2
    5 P1=-.5*SQRT(2.*XRDJND)/SXP+A2AA
      P2=B2BB*SXP*1.5
      P3=2.*C2CC*XP
      IF (IS1I2.EQ.1) P1=-.5*SQRT(2.*XRDJND)/SXP+A2AAU
      IF (IS1I2.EQ.1) P2=B2BBU*SXP*1.5
      IF (IS1I2.EQ.1) P3=2.*C2CCU*XP
      GO TO 2
    4 CONTINUE
      P1=A2AA
      P2=2.*B2BB*XP
      P3=3.*C2CC*XP2
      IF (IS1I2.EQ.1) P1=A2AAU
      IF (IS1I2.EQ.1) P2=2.*B2BBU*XP
      IF (IS1I2.EQ.1) P3=3.*C2CCU*XP2
      GO TO 2
    1 P1=BB
      P2=2.*CB*XP
      P3=3.*DB*XP2
      IF (IS1I2.EQ.1) P1=BBU
      IF (IS1I2.EQ.1) P2=2.*CBU*XP
      IF (IS1I2.EQ.1) P3=3.*DBU*XP2
    2 P4=P1+P2+P3
      P42=P4**2
      P5=1.+P42
      SP5=SQRT(P5)
      F=(XH-XL)*SP5*.5
      RETURN
      END
```

```
      SUBROUTINE MOSEC(A,B,ER1,ER2,X,J,XLPA,IS1I2)
      J=0
      X1=A
      X2=B
    4 J=J+1
      IF(J.GE.800) GO TO 8
      CALL FARC(PFX1,XLPA,X1,IS1I2)
      CALL FARC(PFX2,XLPA,X2,IS1I2)
      X3=X1+(X2-X1)*PFX1/(PFX1-PFX2)
      CALL FARC(PFX3,XLPA,X3,IS1I2)
      IF(PFX3)1,2,3
    1 X2=X3
      X1=X1
      IF(A-B)10,11,11
   10 Y=X3-ER1
      IF(Y.LE.0.) Y=0.
      GO TO 12
   11 Y=X3+ER1
   12 CALL FARC(PFY,XLPA,Y,IS1I2)
      IF(PFY) 5,2,2
    3 X1=X3
      X2=X2
      IF(A-B) 20,20,21
   20 Z=X3+ER1
      GO TO 22
   21 Z=X3-ER1
   22 CALL FARC(PFZ,XLPA,Z,IS1I2)
      IF(PFZ)2,2,5
    5 GO TO 4
    2 PP= ABS(PFX3)
      IF(PP-ER2) 6,6,4
    6 X=X3
      GO TO 7
    8 WRITE(6,9) J
    9 FORMAT(1X,24HJ=,I3)
      STOP
    7 RETURN
      END

      FUNCTION AITKEN(XX,YY,X,N)
      DIMENSION XX(1),YY(1),ZZ(21)
      IF (N)1,1,2
    1 AITKEN=YY(1)
      RETURN
    2 IF (N.GT.20) N=20
      M=N+1
      DO 3 K=1,M
    3 ZZ(K)=YY(K)
      DO 4 I=1,N
      DO 4 J=I,M
    4 ZZ(J+1)=ZZ(I)+(X-XX(I))*(ZZ(J+1)-ZZ(I))/(XX(J+1)-XX(I))
      AITKEN=ZZ(N+1)
      RETURN
      END
```

```
      SUBROUTINE DETERM (A,N,D)
C     DETERM  REVISED 02-28-73
      REAL M
      DIMENSION A(50,50),SAVEA(50,50)
      IF (N .EQ. 1)GO TO 46
      C = 1.
      NN = N
      DO 9 J = 1,NN
      DO 9 I = 1,NN
    9 SAVEA(I,J) = A(I,J)
      K = 1
      GO TO 13
   12 K = K + 1
   13 I = K + 1
      L = K
      GO TO 17
   16 I = I + 1
   17 IF (ABS(SAVEA(I,K)) .GT. ABS(SAVEA(L,K))) L = I
      IF (I .NE. NN)GO TO 16
      IF (L .EQ. K)GO TO 28
      J = K
C     ROW INTERCHANGE
      GO TO 23
   22 J = J + 1
   23 SAVEKJ = SAVEA(K,J)
      SAVEA(K,J) = SAVEA(L,J)
      SAVEA(L,J) = SAVEKJ
      IF (J .NE. NN)GO TO 22
      C = -C
   28 I = K + 1
      GO TO 31
   30 I = I + 1
   31 CONTINUE
      IF (SAVEA(K,K) .EQ. 0.) GO TO 48                                  02-28-73
      M = SAVEA(I,K) / SAVEA(K,K)
      SAVEA(I,K) = 0.
      J = K + 1
      GO TO 36
   35 J = J + 1
   36 SAVEA(I,J) = SAVEA(I,J) - M * SAVEA(K,J)
      IF (J .NE. NN)GO TO 35
      IF (I .NE. NN)GO TO 30
      IF (K .NE. (NN-1))GO TO 12
      D = 1.
      DO 45 I = 1,NN
      J = I
      D = D * SAVEA(I,J)
      IF (ABS(D) .LT. 1.E-36) GO TO 48
   45 CONTINUE
      D = D * C
      RETURN
   46 D = A(1,1)
      RETURN
   48 D = 0.
      WRITE (6,51)
      RETURN
   51 FORMAT(///5X,'ERROR MESSAGE FROM DETERM.'//
     1 5X,'MATRIX IS SINGULAR. DETERMINANT SET = 0.' ///)
      END
```

```
      SUBROUTINE BBBETA(XX,RBETA,IS1I2)
C THIS GIVES BETA(X(XSI)).
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BETAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DBAP,ALFA1,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOO(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),CCC1,CLE,ERC,YYY,XM,IFER4,SXSIC(6),SXSIDD(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LP(,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      ER1=5.E-3
      ER2=5.E-3
      IF(IS1I2.EQ.1) GO TO 20
C IS1I2=0 FOR S1.
C         1 FOR S2.
      LPMAA=LPM-1
      SMALS=SARC(LP)
      IF(LP.EQ.LPM) GO TO 10
      DSS=SARC(LP)-SARC(LP+1)
      XLPA=XX
      GO TO 21
   20 SMALS=SARC2(LP)
      IF(LP.EQ.1)GO TO 110
      XLPA=XX
      DSS=SARC2(LP)-SARC2(LP-1)
   21 CONTINUE
      X1A=XLPA
    4 X1B=X1A+.001
      CALL FARC(FAR,XLPA,X1B,IS1I2)
      IF(FAR.LT.0.) GO TO 3
      X1A=X1B
      GO TO 4
    3 CALL MOSEC(X1A,X1B,ER1,ER2,XX,JII,XLPA,IS1I2)
      GO TO 11
   10 XX=0.
      GO TO 11
  110 XX=XCCC
   11 CALL SHAPE(XX,Y,RBETA,IS1I2)
      RETURN
      END
```

```
      SUBROUTINE FARC(FAR,X_PA,X1B,IS1I2)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,L_PM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DBAP,ALFA1,SAMM
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSV(6),CCC1,CLE,ERC,YYY,XM,IFERA,SXSIO(6),SXSIOD(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAV(513),BETAM(513),IJ,LPX,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      IF(XLPA.EQ.X1B) GO TO 1
      CALL ARCLEN(XSS,X_PA,X1B,IS1I2)
      GO TO 2
    1 XSS=0.
    2 CONTINUE
      FAR=DSS-XSS
      RETURN
      END
```

6.0 LISTING OF PCASLE

```
      PROGRAM PCASLE(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE7,TAPE1)
C
C
C  NON-LINEAR PARTIALLY CAVITATING CASCADE CALCULATIONS.
C  8/17/1978 PROGRAMMED BY D. FURUYA.
C-----PROGRAM REVISED  FOR FIXED CAVITY LENGTH VERSION ON 9/15/78.
C          OPEN WAKE MODEL.    (9/15/1979)
C
C
      DIMENSION YBE(7),XZ(7),BETAN0(513),BETAM0(513),BETA02(100)
      DIMENSION SXSI(7),XXX(513),CP(513)
      DIMENSION F_(200),FJ(200),CP2(101),XXX2(201),F_2(100),FJ2(100)
      COMMON/FOILEND/XXDD,YYDD
      COMMON/UPPER/A2AAJ,B2BBU,C2CCJ,AAAAJ,BBBBJ,CCCCJ,A8J,B8J,C8U,D8U
      COMMON /CVTYL/CAVLEN,BIGS2
      COMMON/FREECAV/XFREEC,YFREEC
      COMMON/DELTAD/DELT(7,7)
      COMMON/THICK/TH
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSS2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,_PMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DJAP,ALFA1,BAMM
      COMMON       BBETA,KKM,ICPI,SARCOD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(7),      CLE,ERC,YYY,KM,IFERA,SXSID(7),SXSIDD(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),KJJ(200),XDX
      COMMON XROJND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
C BETAN----FOR ARC 1  FOR REGULAR INTEGRAL.
C BETAN IS FOR INTERPOLATED VERSION OF BETAN .
C BETAN2 FOR EQUALLY SPACED INCREMENT FOR ARC 2.
C BETAN2 FOR CHEBYCHEV- GAUSS VERSION OF BETAN2.
      PAI=3.141592653
      READ(5,795) NGAUS
      NGAUS1=NGAUS+1
      NNN2=NGAUS/2
      NGAUS2=NNN2+1
      READ(5,560) (TGAUS(I),I=NGAUS2,NGAUS)
      READ(5,560) (WGAUS(I),I=NGAUS2,NGAUS)
      DO 26 IQ=1,NNN2
      TGAUS(IQ)=-TGAUS(NGAUS1-IQ)
   26 WGAUS(IQ)=WGAUS(NGAUS1-IQ)
      WRITE(6,561) (TGAUS(I),I=NGAUS2,NGAUS)
      WRITE(6,562) (WGAUS(I),I=NGAUS2,NGAUS)
  560 FORMAT(4F20.10)
  561 FORMAT(1X,'T(I)=',10(F10.8,1X))
      READ (5,590) XXM


      DO 589 IDELTA=1,7
  589 READ (5,590) (DELT(IDELTA,I),I=1,7)
  562 FORMAT(1X,'W(I)=',10(F10.8,1X))


C                                                  DDYY,DDXX,HT 9065,5(DAER
      READ(5,560) TH
      READ(5,560) R,AAAA,BBBB,CCCC
      READ(5,560) A8,B8,C8,D8
```

```
      READ(5,563) XROUND,A2AA,B2BB,C2CC
      READ(5,560) AAAAU,BBBBU,CCCCU
      READ (5,550) A8U,B8U,C8U,D8U
      READ (5,550) A2AAU,B2BBU,C2CCU
      READ(5,795)          NCHBY
      READ(5,1321) SBETA ,SBETA2,SF4,BETA3,BETAC
      READ(5,551) LPMS,LPXS,LPM2,IFLAG,IREAD,ISHARP
      READ(5,201) NITER,MSIDP,MAXIT,NHK
      READ(5,202) ALFA1S,GAMMAS,SDLIS,   CAVLEN
      READ(5,229) DE,DG,DF
C CAVLEN IS A CAVITY LENGTH SPECIFIED.
      DO 592 IDELTA=1,7
  592 WRITE (6,591) (DE_T(IDELTA,I),I=1,7)


      WRITE(6,6553)
 6553 FORMAT(1H1)
      READ(5,6556) ESPACE
 6556 FORMAT(F10.5)
      WRITE(6,6557) ESPACE
 6557 FORMAT(1X,///,1X,*ESPACE=*,F5.2,///)
      WRITE (6,5590) TH,XKH
      WRITE(6,5651) BETA8,BETAC
      WRITE(6,555) R,AAAA,BBBB,CCCC
      WRITE(6,556) A8,B8,C8,D8
      WRITE(6,557) XROUND,A2AA,B2BB,C2CC
      WRITE (6,523) AAAAJ,BBBBJ,CCCCJ
      WRITE(6,524) A8U,B8U,C8U,D8U
      WRITE(6,525) A2AAJ,B2BBJ,C2CCJ
      WRITE(6,1229) LPMS,LPXS,SBETA,IREAD,NCHBY
      WRITE(6,1324) DE,DG,DF,SF4
      WRITE(6,1321) SBETA2
  523 FORMAT(20X,*AAAAU=*,F10.6,2X,*BBBBU=*,F10.6,2X,*CCCCU=*,F10.6)
  524 FORMAT(20X,*A8J=*,F10.6,2X,*B8J=*,F10.6,2X,*C8J=*,F10.6,2X,*D8U=*,
     1 F10.6)
  525 FORMAT(20X,*A2AAU=*,F10.6,2X,*B2BBJ=*,F10.6,2X*C2CCJ=*,F10.6)
  550 FORMAT (8F10.8)
  591 FORMAT (10X,*DE_TA(I,J)=*,7(F10.8,2X))
 5590 FORMAT (20X,*THICKNESS OF FLAND CONVEX FOIL = *,F10.5,10X,*XKH=*,
     1F10.5)
  555 FORMAT(20X,*R=*,F5.2,2X,*AAAA=*,F10.6,2X,*BBBB=*,F10.6,2X,*CCCC=*,
     XF10.6)
  556 FORMAT(20X,*A8=*,F10.6,2X,*B8=*,F10.6,2X,*C8=*,F10.6,2X,*D8=*,F10.
     6)
  557 FORMAT(20X,*XROUND=*,F10.6,2X,*A2AA=*,F10.6,2X,*B2BB=*,F10.6,2X,*C
     (2CC=*,F10.6)
  795 FORMAT(8I10)
C AAAA,BBBB,CCCCARE CONSTANTS FOR 2-TERM CAMBER, X AND SQRT(X)
C  --------CALCULATED FROMANOTHER PROGRAM CALLED *CAMBER*----------.
C A8,B8,C8 AND D8 ARE COEFFICIENTS FOR POLYNOMIALS FOR X GREATER THAN .8.
C CLOD AND CLOOK ARE NOW DUMMY.
C SF4 IS USED FOR DETERMINING WHETHER TO CALCULATE BETA.
 1321 FORMAT(5E14.7)
C IFLAG=1 NEEDS DATA CARDS FOR SXSI(I), I=1,5, IREAD MAY BE SET TO 5.
C IF IFLAG=0 , DATA WILL BE READ EITHER FROM
C         DATA CARD, IF IREAD=5
C         TAPE1    , IF IREAD=1.
  551 FORMAT(10I3)
  201 FORMAT(4I3)
  202 FORMAT(4E14.7)
```

```
C DE,DG,DF ARE THE INCREMENTS FOR DERIVATIVES IN DXFNEW.
C DG=1.E-3 $ DF=1.E-5 ARE USED BEFORE.
  229 FORMAT(3E14.7)
 1229 FORMAT(5X,4HLPM=,I4,2X,4HLPK=,I4,2X,5HSBETA=,E14.7,5X,6HIREAD=,I1,
     X2X,*NCHBY=*,I3)
 5551 FORMAT(20X,*BETAB AND BETAC AS FIRST GUESS=*,F10.5,2X,F10.5)
 1324 FORMAT(10X,3HDE=,E14.7,2X,3HDG=,E14.7,3HDF=,E14.7,2X,4HSF4=,E14.7)
 1521 FORMAT(10X,*SBETA2=*,E14.7)
      SBETA2=SBETA2*PAI/180.
      BETAB=BETAB*PAI/180.
      BETAC=BETAC*PAI/180.
C   LPMM=LPM2=NS2
      LPMM=LPM2
      NS2=LPM2
      LPMM1=LPMM+1
      WRITE(6,1439) LPM2,ISHARP
 1439 FORMAT(10X,*LPM2=*,I3,2X,*ISHARP=*,E14.7)
C ISHARP=0 FOR SHARP L.E.
C         1 FOR ROUNDED L.E.
      SBETA=SBETA*PAI/180.
      DO 999 IJKL=1,NITER
C FFF4 IS PROVIDED FROM DXFNEW, BUT IF THE LOOP DOES NOT GO THROUTH
C     IT, FFF4 OF PRESET VALUE MUST BE USED.
      FFF4=0.
      ALFA1D=ALFA1S
      GAMMAD=GAMMAS
      SOLID=SOLIS
      IF(NHK.EQ.1) GO TO 240
      IF(NHK.EQ.2) GO TO 241
      SOLID=SOLIS+0.1*FLOAT(IJKL-1)
      GO TO 243
  241 GAMMAD=GAMMAS+2.*FLOAT(IJKL-1)
      GO TO 243
  240 ALFA1D=ALFA1S-2.*FLOAT(IJKL-1)
  243 CONTINUE
      XM=XXM
      ALFA1=ALFA1D*PAI/180.
      DGAP=1./SOLID
      GAMMA=GAMMAD*PAI/180.
      DELTA=ALFA1+GAMMA
      FLAPAN=0.
      WRITE(6,666) ALFA1D,GAMMAD,SOLID
  666 FORMAT(1X,16HINCIDENCE ANGLE=,E14.7,1X,6HGAMMA=,E14.7,1X,9HSOLIDIT
     XY=,E14.7)
      WRITE(6,663) FLAPAN
  663 FORMAT(5X,11HFLAP ANGLE=,E14.7)
      STOLL=2.E-4
      STOLS=5.E-4
      ERC=1.E-2
      CLE=1.E-4
      WRITE(6,511) CAVLEN
  511 FORMAT(10X,*CAVITY LENGTH=*,E14.7)
C SPECIFY HYDROFOIL'S CHARACTERISTICS AND SEP. POINTS.
      XC=0.
      YC=0.
      XB=0.
      XA=1.
      XXDD=1.00000
      YYDD=A3U+B3U+C3U+D3U
      WRITE(6,502) XA,XB,XC,YC,XXDD,YYDD
```

```
  502 FORMAT(10X,54HCHORD=,E14.7,2X,17HUPPER SEP. POINT=,E14.7,2X,20HCONN
     X. POINT(XC,YC)=(,E14.7,1H,,E14.7,1H)/*  XXDD=*,F10.5,2X,*YYDD=*,
     Y F10.5)
C START ITERATIVE PROCEDURE.
C     -----BASIC FLOW IS THAT OF FLAT PLATE-----.
C ITERAT IS INDEX FOR NUMBER OF ITERATIONS.
      ITERA=1
      IF(IFLAG.EQ.0) ITERA=2
      BIGS=0.
      XHIGH=0.
      XLOW=0.
      IS112=0
      XINCRT=XA/50.
      DO 248 IINC=1,50
      XLOW=XHIGH
      XHIGH=XLOW+XINCRT
      CALL ARCLEN(S,XLOW,XHIGH,IS112)
  248 BIGS=BIGS+S
C ----FIND BIGS2-----
C         FIRST CALL SHAPE TO FIND A CORRESPONDING TO CAVLEN.
      XCCC=CAVLEN
      XFREEC=CAVLEN
      CALL SHAPE(CAVLEN,Y,BETA,3)
      YFREEC=Y
      YCCC =Y
      CALL ARCS2(BIGS2,CAVLEN,Y)
      WRITE(6,504) BIGS,BIGS2
  504 FORMAT(10X,5HBIGS=,E14.7,5X,*BIGS2=*,E14.7)
      STOL=1.E-5
      LPM=LPMS
      LP1=LP1S
      LPM1=LPM-1
      LPM3=LPM-3
C ICPI IS USED FOR CONTROLLING PROGRAM; 0 FOR ITER. 1 FOR THE REST.
C FIND XSIB,XSIC,XSIF,A,ALFA2 BY USING NEWTON,S METHOD.
C SXSI(1)=XSIB
C SXSI(2)=XSIC
C SXSI(3)=XSIF
C SXSI(4)=A WHICH IS THE COEFFT. OF MAPPING FCN.
C SXSI(5)=ALF2
C SXSI(6)=SIGMA
C SXSI(7)=ESPACE  (RATIO OF SPACE OF BLADES AT UPSTREAM AND DOWNSTREAM)        C
      IF(IJK.GE.2) GO TO 630
      IF(IFLAG.EQ.0) GO TO 779
C INATIAL GUESS FOR SXSI(I) IS ----------
      READ(5,768) SXSI(1),SXSI(2),SXSI(3),SXSI(4),SXSI(5),SXSI(6)
     X            ,SXSI(7)                                                    C
      GO TO 150
  779 READ(IREAD,620) SXSI(1),SXSI(2),SXSI(3),SXSI(4),SXSI(5),SXSI(6)
     X            ,SXSI(7)                                                    C
  620 FORMAT(7F10.7)
  629 DO 621 IC=1,LPM
  621 READ(IREAD,622) SARC(IC),BETAN(IC)
  622 FORMAT(2E14.7)
      DO 1621 IC=1,LPM1
 1621 READ(IREAD,622) SARC2(IC),BETAN2(IC)
      IF(IFLAG.EQ.0) GO TO 480
      GO TO 481
  480 DO 482 IBT=1,LPM1
  482 BETAM(IBT)=.5*(BETAN(IBT)+BETAN(IBT+1))
```

```
  431 CONTINUE
  150 ICPI=0
      WRITE(6,102) ITERA
  102 FORMAT(10X,14HITERATION NO.=,I2)
      DO 850 IRP=1,7                                                    C
  850 SXSID(IRP)=SXSI(IRP)
      IF(ITERA.GE.2) STOL=STOLS
      IF(ITERA.EQ.MSTOP) STOL=STOLL
C
C
C
C
      CALL DXFNEW(SXSI,STOL,MAXIT,ITN,DS,DF,FFF4)
C
C
C
C
  550 CONTINUE
      DO 537 ID1=1,7                                                    C
      XSN(ID1)=SXSI(ID1)
  537 WRITE(6,536) ID1,SXSI(ID1)
  536 FORMAT(10X,5HSXSI(,I1,2H)=,E14.7)
      CSPACE=(1.+SXSI(1))/FLOAT(LPK)
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(LPM-LPK)
      HFSPAC=0.5*FSPACE
      XBET=-1.+CSPACE*FLOAT(LPK-1)
      ICPI=1
C ICPI=0 FOR FINDING SXSI(I), I.E., SXSI(I)=YXS(I)≥ ICPI=1 FOR THE REST.
C CALCULATION OF PRESSURE DISTRIBUTION ?CP?.
      IF(ITERA.EQ.1) GO TO 36
      DO 35 IB=1,LPM
   35 BETAN0(IB)=BETAN(IB)
      DO 37 IB=1,LPM1
   37 BETAN1(IB)=BETAN2(IB)
      DO 355 IB=1,LPMM1
  355 BETA02(IB) = BETAN2(IB)
   36 CONTINUE
      JJ2=COS(ALFA1+GAMMA)/COS(SXSI(5)+GAMMA)/SXSI(7)                   C
      JJ22=JJ2**2
      DO 25 LG=1,LPM
      LP=LG
C FIND CP(XSIP) NEXT.
C----- FOR THE FIRST BETTED ARC PORTION S1-----
C     CP IS BASED  ON U1 AND P1.
C     LP=1 IS NEAR THE T.E.
C     LP=LPM IS NEAR THE L.E.
      IF(LP.EQ.1)  GO TO 521
      IF(LP.EQ.LPM) GO TO 52
      Q2=EXP(XITN(LP))
C XITN(I) IS CALCULATED IN DFSIM2 OF DXFNEW FOR F(4).
      Q2=Q2**2
      CP(LP)=1.-JJ22*Q2
      GO TO 522
   52 CP(LP)=-SXSI(6)
      GO TO 522
  521 CP(LP)=1.-JJQ2
  522 CONTINUE
   25 CONTINUE
C                                                                       *
```

```
C
C**********MAIN INSERT 1*************************************************
C                                                                       *
C                                                                       *
C-------CP FOR THE SECOND ARC S2-------
C         NUMBER OF CONTROL POINTS ON S2 IS FIXED
C         IN SUBROUTINE OFSIMS, I.E.,
C            HALF OF THE POINT USED FOR BETA
C         ANSG2S IN COMMON = G2.
      DO 680 NCP = 1,LPMM1
      IF(NCP.EQ.1) GO TO 681
      IF (NCP.EQ.LPMM1) GO TO 682
      G2 = EXP(ANSG2S(NCP))
      G2 = G2**2
      CP2(NCP) = 1.-G2*UU22
      GO TO 680
  681 CP2(NCP)=-SXSI(6)
      GO TO 680
  682 CP2(NCP) = 1.-UU22
  680 CONTINUE
C                                                                       *
C                                                                       *
C**********MAIN INSERT 1*************************************************
C


      AF4=ABS(F(4))
      IF(AF4.GE.SF4) GO TO 1135
      GO TO 1134
 1135 WRITE(6,1136)
 1136 FORMAT(5X,'F(4) IS TOO LARGE TO CALCULATE BETA')
      STOP
C FIND XXX(XSIP) FIRST.
 1134 CONTINUE
      IS1S2=0
C-----FIRST BETA FOR ARC 1-----.
      DO 100 LL=1,LPM
      LP=LPM-LL+1
      CALL BBBETA(XYX,BETA,IS1S2)
      XXX(LP)=XYX
      BETAN(LP)=BETA
      IF(LP.EQ.LPM) BETAB=BETA
      IF(ITERA.LE.MSTOP1) GO TO 100
      WRITE(6,101) LP,SARC(LP),XXX(LP),CP(LP),BETAN(LP)
  100 CONTINUE
  101 FORMAT(1X,2HI=,I3,1X,5HSARC=,E14.7,1X,4HXXX=,E14.7,1X,3HCP=,E14.7,
     *1X,5HBETAN=,E14.7)
C
C**********MAIN INSERT 2*************************************************
C                                                                       *
C                                                                       *
C----------BETA FOR ARC S2----------.
C            SARC2 HAS BEEN CALCULATED
C            IN SUBROUTINE OFSIMS AND
C            STORED IN COMMON AREA.
      IS1S2 = 1
      DO 429 LL=1,LPMM1
      LP=LL
      CALL BBBETA(XYX,BETA,IS1S2)
      IF(LP.EQ.1) BETAC=BETA
```

```
      XXX2(LP) = XYX
      BETAN2(LP) = BETA
      IF(ITERA.LE.MSTOP1) GO TO 329
      WRITE(5,239) LP,SARC2(LP),XX(X2(LP),CP2(LP),BETAN2(LP)
  239 FORMAT(9X,*I=*,I3,1X,*SARC2=*,E14.7,1X,*XXX2=*,
     *E14.7,1X,*CP2=*,E14.7,1X,*BETAN2=*,E14.7)
  329 CONTINUE
  429 CONTINUE
C                                                                              *
C                                                                              *
C**********MAIN INSERT 2***************************************************
C
C
C**********MAIN INSERT 3 ***************************************************
C                                                                              *
C                                                                              *
C FIND LIFT AND DRAG.
C----------FIRST CL AND CD FOR S1 PART.
      USID = SIN(DELTA)
      UCOD = COS(DELTA)
      UXB = SXSI(4)*UCOD
      UXB2 = UXB**2
      DO 105 ITK = 1,LPM
      IF(ITK.GT.LPK) GO TO 106
      XPS = -1.*DSPACE*FLOAT(ITK-1)
      GO TO 108
  106 XPS = XBET+FSPACE*FLOAT(ITK-LPK)
  108 CONTINUE
      UXA = XPS-SXSI(4)*USID
      UXA2 = UXA**2
      PXXP = UCOD/(UXA2+UXB2)
      DWDX = DGAP*PXXP*XPS/PAI
      COBET1      = COS(BETAN(ITK))
      SIBET1      = SIN(BETAN(ITK))
      DS1DX = -EXP(-XITN(ITK))*DW  /UU22
C     G1 IS CALCULATED AT DFSIM2  , XITN(I).
C     AND STORED IN COMMON.
      IF(XPS.LT.0.) DS1DX = -DS1.
      XLP1 = DS1DX*CP(ITK)
      FL(ITK) = -XLP1*COBET1
      FD(ITK) = XLP1*SIBET1
  105 CONTINUE
C-----CL AND CD FOR S2 PART.
      NS21=NS2+1
      NS2A=NS2-1
      GAP2 = (SXSI(3)-SXSI(2))/NS2
      DO 533 ITK = 1, NS21
      XRS2 = SXSI(2)+GAP2*(ITK-1)
      UXA = XRS2-SXSI(4)*USID
      UXA2 = UXA**2
      PXXP = UCOD/(UXA2+UXB2)
      DWDX = DGAP*PXXP*XRS2/PAI
      COBET2 =-COS(BETAN2(ITK))
      SIBET2 =-SIN(BETAN2(ITK))
      DS2DX = EXP(-ANSS2S(ITK))*DWDX/UU22
C     S2 IS ALREADY CALCULATED AT DFSIM5 AS
C     ANSS2S(I). STORED IN COMMON AREA.
      XLP2 =  DS2DX*CP2(ITK)
      FL2(ITK) =-XLP2*COBET2
      FD2(ITK) =  XLP2*SIBET2
```

```
  338 CONTINUE
      SPACE = CSPACE
      CLIFT = 0.5*CSPACE*FL(2)+0.5*FSPACE*FL(LPM1)
      CDRAG = 0.5*CSPACE*FD(2)+0.5*FSPACE*FD(LPM1)
      DO 111 IUA = 2,LPM3,2
      IF(IUA.GE.LPK) SPACE = FSPACE
      CLIFT = CLIFT+SPACE*(FL(IUA)+4.*FL(IUA+1)+FL(IUA+2))/3.
  111 CDRAG = CDRAG+SPACE*(FD(IUA)+4.*FD(IUA+1)+FD(IUA+2))/3.
      DO 321 IUA = 1,NS2A,2
      CLIFT = CLIFT+GAP2*(FL2(IUA)+4.*FL2(IUA+1)+FL2(IUA+2))/3.
  321 CDRAG = CDRAG+GAP2*(FD2(IUA)+4.*FD2(IUA+1)+FD2(IUA+2))/3.
C-----ADD THE FORCES ON CAVITY PORTIONS.
C     SUBROUTINE XCYC CALCULATES
C   THE POINT ON THE UPPER BLADE PORTION CORRESP. TO THE CAVITY END POINT.
      CXA=XCCC
      CYA=YCCC
      CALL XCYC(XCCCB,YCCCB,CXA,CYA)
      CLIFT = CLIFT+SXSI(5)*XCCCB
      CDRAG = CDRAG-SXSI(5)*YCCCB
C-----XCCC AND YCCC ARE THE END POINTS OF CAVITY, CALCULATED IN
C     SUBROUTINE CAVITY
C     STORED IN COMMON.
C                                                                              *
C                                                                              *
C**********MAIN INSERT 3 ************************************************************
C
C
C END BINF IN 2-1.
      U2U1=COS(ALFA1+GAMMA)/COS(SXSI(5)+GAMMA)/SXSI(7)                         C
      DOWN=COS(ALFA1+GAMMA)*COS(SXSI(5)+GAMMA)
      BINF=0.5*SIN(ALFA1+SXSI(5)+2.*GAMMA)/DOWN
      BINF=ATAN(1./BINF)
      AINF=0.5*PAI-BINF-GAMMA
C CDSTAR AND CLSTAR ARE BASED ON VELOCITY AT UPSTREAM INFINITY IN (X,Y).
      CDSTAR=CDRAG
      CLSTAR=CLIFT
      UINF=0.5*SQRT(1.+U2U1**2+2.*U2U1*COS(ALFA1-SXSI(5)))
      FINF=2.*DGAP*SIN(ALFA1-SXSI(5))/(UINF*COS(SXSI(5)+GAMMA))
      CLINF=CLSTAR*COS(AINF)-CDSTAR*SIN(AINF)
      CDINF=CLSTAR*SIN(AINF)+CDSTAR*COS(AINF)
      CLINF=CLINF/UINF**2
      CDINF=CDINF/UINF**2
      WRITE(6,117) CLINF,CDINF
  117 FORMAT(1X,34HCLINF OR CDINF=FORCE/1/2RO.UINF**2,5X,6HCLINF=,E14.7,
     X1X,6HCDINF=,E14.7)
      WRITE(6,118) FINF
  118 FORMAT(1X,34HFINF IS OBTAINED FROM MOMENTUM EQN,5HFINF=,E14.7)
      WRITE(6,221)
  221 FORMAT(1X,48H---CLL, & CDD ARE BASED ON U1 IN ALFA1 DIRE.---)
      CLL=CLSTAR*COS(ALFA1)-CDSTAR*SIN(ALFA1)
      CDD=CLSTAR*SIN(ALFA1)+CDSTAR*COS(ALFA1)
      ALOD=CLL/CDD
      WRITE(6,181) CDD,CLL,ALOD
  181 FORMAT(1X,5HCDD=,E14.7,1X,5HCLL=,E14.7,1X,4HL/D=,E14.7)
      MSTOP1=MSTOP-1
      IF(ITERA.LE.MSTOP1) GO TO 140
C
C
C**********MAIN INSERT 4 ************************************************************
C                                                                              *
```

AD-A081 832 TETRA TECH INC PASADENA CA F/G 9/2
COMPUTER PROGRAMS FOR CALCULATING PARTIALLY CAVITATING BLUNT TR--ETC(U)
JAN 80 S MAEKAWA, O FURUYA N00014-79-C-0234
UNCLASSIFIED TETRAT-TC-3284-02 NL

2 OF 3
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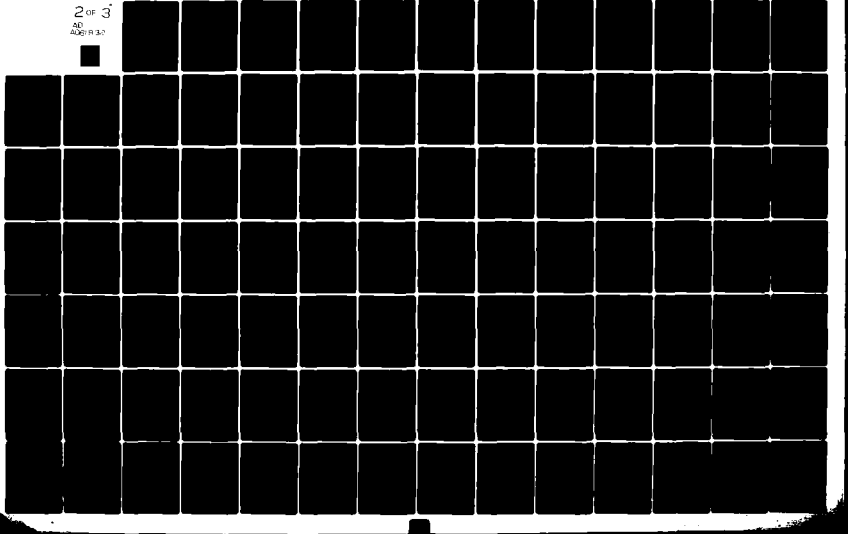

```
C                                                                       *
C     CAVITY SHAPE.                                                     *
C        ALREADY CALCULATED IN                                          *
C        SUBROUTINE CAVITY.                                             *
      WRITE(6,297)
  297 FORMAT(2X,'----CAVITY SHAPE-----')
      NCAV1=NCAV+1
      DO 295 ICAV=1,NCAV1,2
  295 WRITE(6,296) CAVX(ICAV ),CAVY(ICAV )
  296 FORMAT(10X,'X=',E14.7,10X,'Y=',E14.7)
C                                                                       *
C                                                                       *
C**********MAIN INSERT 4 ***************************************************
C
  140 CONTINUE
      XCCC=0.
      YCCC=0.
      WRITE(6,823)
  823 FORMAT(//,'----------UPPER BODY SHAPE----------')
      DO 321 ISHP=1,51
      X=.02*(ISHP-1)
      CALL SHAPE (X,Y,BETA,3)
  321 WRITE(6,822) X,Y
  322 FORMAT(5X,'X=',F10.5,2X,'Y=',F10.5)
      RE=IND 7
      WRITE(7,758) SXSI(1),SXSI(2),SXSI(3),SXSI(4),SXSI(5),SXSI(6)
     X      ,SXSI(7)                                                   C
  758 FORMAT(7F10.7)
      DO 766 IC=1,LPM
  766 WRITE(7,767) SARC(IC),BETAN(IC)
  767 FORMAT(2E14.7)
      DO 1766 IC=1,LPMM1
 1766 WRITE(7,767) SARC2(IC),BETAN2(IC)
      IF(ITERA.GE.MSTOP) GO TO 999
      LPK1=LPK-1
      SPACE=CSPACE
      HSPACE=HCSPAC
      DO 50 IM=1,LPM1
      IF(IM.EQ.1) GO TO 51
      IF(IM.EQ.LPM1) GO TO 55
      IF(IM.EQ.LPK1) GO TO 97
      IF(IM.EQ.LPK) GO TO 98
      IF(IM.GT.LPK) GO TO 93
      XY=-1.+SPACE*FLOAT(IM-1)+HSPACE
      XZ(1)=-1.+SPACE*FLOAT(IM-2)
      XZ(2)=XZ(1)+SPACE
      XZ(3)=XZ(2)+SPACE
      XZ(4)=XZ(3)+SPACE
      GO TO 99
   93 SPACE=FSPACE
      HSPACE=HFSPAC
      XY=XBET+HSPACE+ SPACE*FLOAT(IM-LPK)
      XZ(1)=XBET+SPACE*FLOAT(IM-LPK-1)
      XZ(2)=XZ(1)+SPACE
      XZ(3)=XZ(2)+SPACE
      XZ(4)=XZ(3)+SPACE
   99 DO 56 IK=1,4
   56 YBE(IK)=BETAN(IM+IK-2)
      BETAN(IM)=AIT(EV(XZ,YBE,XY,3)
```

```
      GO TO 151
   97 BETAM(LPK1)=0.5*(BETAN(LP(1)+BETAN(LPK))
      GO TO 151
   98 BETAM(LPK)=0.5*(BETAN(LP()+BETAN(LP(+1))
      GO TO 151
   51 BETAM(1)=0.5*(BETAN(1)+BETAN(2))
      GO TO 151
   55 BETAM(LPM1)=0.5*(BETAN(LPM1)+BETAN(LPM))
  151 CONTINUE
   50 CONTINUE
      IF(ITERA.EQ.1) GO TO 6
      DO 41 IE=1,LPM
   41 BETAN(IE)=BETAN(IE)*(1.-XXM)+BETAND(IE)*XXM
      DO 42 IFG=1,LPM1
   42 BETAM(IFG)=BETAM(IFG)*(1.-XXM)+BETAMD(IFG)*XXM
      DO 425 IFG=1,LPMM1
  425  BETAN2(IFG) = BETAN2(IFG)*(1.-XXM)+BETAD2(IFG)*XXM
      DO 652 IRP=1,7                                                    C
  652 SXSI(IRP)=SXSI(IRP)*(1.-XXM)+SXSID(IRP)*XXM
    6 ITERA=ITERA+1
      IF(ITERA.GT.MSTOP) GO TO 28
      GO TO 160
   28 WRITE(6,29)
   29 FORMAT(5X,25HITERATION WAS TERMINATED.)
  999 CONTINUE
      STOP
      END
```

```
      SUBROUTINE DXFNEW(X,STOL,M,I,DG,DF,FFF4)
      DIMENSION F(7),P(50,7),X(7),Q(7,7),XRRI(7),XMMI(7)
      COMMON/DELTAD/DELT(7,7)
      COMMON /CVTYL/CAVLEN,BIGS2
      COMMON/FREECAV/XFREEC,YFREEC
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAS,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DBAP,ALPHA1,BAMMA
      COMMON        SBETA,XMM,ICPI,SARCD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XL3IGS,BIGS,SMALS,OSS
      COMMON XSV(7),     CLE,ERC,YYY,KM,IFERA,SXSID(7),SXSIDD(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPM,XII(200),XJJ(200),XDX
      COMMON XRDJND,A2AA,B23B,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TBAJS(100),WBAWS(100),NGAUS
      PAI=3.1+1592653
      I=0
      IF(IFERA.LE.3) GO TO 272
      DO 67 IIJ=1,7                                                    C
   67 WRITE(6,66) IIJ,X(IIJ)
   66 FORMAT(1X,24H(,I1,24H)=,E14.7)
  272 CONTINUE
   55 SI1=2.+DE
      SI6=2.+DG
      IF(X(1).LT.SI1) X(1)=SI1
      SI10=X(1)+2.+DG
      IF(X(2).LT.SI10) X(2)=SI10
      SI11=X(2)+2.+DG
      IF(X(3).LT.SI11) X(3)=SI11
      IF(X(4).LT.SI6) X(4)=SI6
      SI5=(0.5+PAI-GAMMA)+(1.-0.02)
      IF(X(5).LT.0.) GO TO 78
      IF(X(5).GT.SI5) X(5)=SI5
      GO TO 79
   78 IF(ABS(X(5)).GT.SI5) X(5)=-SI5
   79 CONTINUE
      IF (X(7).LE.0.) WRITE(6,1123)                                    C
 1123 FORMAT(2X,+----------X(7) IS LESS THAN ZERO----------+)          C
      IF(X(5).LE..001) X(5)=.001
      DO 68 IIJ=1,7                                                    C
   68 WRITE(6,66) IIJ,X(IIJ)
      IJ=1
C-----F(1)-------------------------------------------------------------
      DO 20 I<=1,7                                                     C
   20 YXS(I<)=X(I<)
    5 CONTINUE
      KCTRL = 1
      CALL FIINT(YINT1,KCTRL)
C     SUBROUTINE FIINTL CALCULATES THE INTEGRALS IN F(1).
      KCTRL = 2
      CALL FIINT (YINT2,KCTRL)
      KCTRL = 3
      CALL FIINT (YINT3,KCTRL)
      KCTRL = 4
      CALL FIINT (YINT4,KCTRL)
      CCC1=ALOG(1.+YXS(6))/(2.+PAI)
      CS1 = ALOG(COS(YXS(5)+BAMMA)/COS(ALPHA1+BAMMA)+YXS(7))           C
      FA = -(YINT1/PAI+YINT2-(CCC1+CS1/PAI)+YINT3
```

```
     1+YINT4/PAI-YXS(5))
       IF (IJ.EQ.1) WRITE (5,70) YINT1,YINT2,YINT3,YINT4
  70 FORMAT (10X,'--I-I1,I2,I3,I4 OF F(1) ARE----',4(E14.7,2X))
       IF (IJ.EQ.1) F(1) = FA
       IF (IJ.EQ.2) GO TO 3
       IF (IJ.EQ.3) GO TO 4
       IF (IJ.EQ.4) GO TO 320
       IF (IJ.EQ.5) GO TO 321
       IF (IJ.EQ.6) GO TO 322
       IF(IJ.EQ.66) GO TO 3222
       P(1,5) = TAN(YXS(5)+GAMMA)+YINT3/PAI-1.
       P(1,6)=-YINT3/(2.*PAI+(1.+Y(S(6)))
       P(1,7)=-YINT3/(PAI+Y(S(7))                                          C
       IJ = 2
       YXS(1) = X(1)+DELT(1,1)
       GO TO 5
     3 F1P = -FA
       IJ = 3
       YXS(1) = X(1)-DELT(1,1)
       GO TO 5
     4 F1Q = -FA
       P(1,1) = (F1P-F1Q)/(2.*DELT(1,1))
       IJ = 4
       YXS(1) = X(1)
       YXS(2) = X(2)+DELT(1,2)
       GO TO 5
   320 F1P = -FA
       YXS(2) = X(2)-DELT(1,2)
       IJ = 5
       GO TO 5
   321 F1Q = -FA
       P(1,2) = (F1P-F1Q)/(2.*DELT(1,2))
       Y(S(2) = X(2)
       YXS(3) = X(3)+DELT(1,3)
       IJ = 6
       GO TO 5
   322 F1P = -FA
       IJ=66
       YXS(3)=X(3)-DELT(1,3)
       GO TO 5
  3222 F1Q=-FA
       YXS(3)=X(3)
       P(1,3) = (F1P-F1Q)/(2.*DELT(1,3))
       P(1,4) = 0.
C------F(2) AND F(3)-----------------------------------------------------
       IJ = 7
   330 CONTINUE
       XKKX = ALOG(COS(ALFA1+GAMMA)/COS(YXS(5)+GAMMA)/YXS(7))              C
       XK1  = YXS(4)*SIN(DELTA)
       YY1  = YXS(4)*COS(DELTA)
       YY12=YY1**2
       CCC1=ALOG(1.+YXS(6))/(2.*PAI)
       CON1 = CCC1-XKKX/PAI
       ERR = 0.
       XMM = 0.
       DO 331 MIQ = 1,4
       CALL RMINT(SOLNR,SOLNM,MIQ)
       XRRI(MIQ) = SOLNR
       XMMI (MIQ) = SOLNM
       XRRR = -XRRI(MIQ)/PAI
```

```
      X999 = -X99I(9I3)/PAI
      IF (MIQ.EQ.1) XRRR = CON1*XRRI(MIQ)
      IF (MI3.EQ.1) X999 = CON1*X99I(9I3)
      IF (MIQ.EQ.4) XRRR = -XRRI(9IQ)
      IF (MI3.EQ.4) X999 = -X99I(9I3)
      IF (IJ.EQ.7) WRITE (6,71) (XRRI(I),I=1,4)
      IF (IJ.EQ.7) WRITE (6,72) (X99I(I),I=1,4)
   71 FORMAT(10X,'----XRRI(I),I=1,4 OF F(2) AND F(3) ARE----',4(E14.7,2X))
   72 FORMAT(10X,'----XMMI(I),I=1,4 OF F(2) AND F(3) ARE----',4(E14.7,2X))
      XRR = XRR+XRRR
      X99 = XMM+X999
  351 CONTINUE
C-----CALCULATION OF H1(ZETA1)-------.
      XSIP1 = XX1+1.
      XSI9B = XX1-YYS(1)
      XSI9F = XX1-YYS(3)
      XSI9C = XX1-YYS(2)
      XSIP12 = XSIP1**2
      XSI9B2 = XSI9B**2
      XSI9F2 = XSI9F**2
      XSI9C2 = XSI9C**2
      RRA = SQRT(XSIP12+YY12)
      RRB = SQRT(XSIMB2+YY12)
      RRC = SQRT(XSI9F2+YY12)
      RRD = SQRT(XSI9C2+YY12)
      TH1A = ATAN(YY1/XSIP1)
      IF (XSIP1.LE.0.) TH1A = PAI+TH1A
      TH1B = ATAN(YY1/XSI9B)
      IF (XSI9B.LE.0.) TH1B = PAI+TH1B
      TH1C = ATAN(YY1/XSI9F)
      IF (XSI9F.LE.0.) TH1C = PAI+TH1C
      TH1D = ATAN(YY1/XSI9C)
      IF (XSI9C.LE.0.) TH1D = PAI+TH1D
      RR1 = SQRT(RRA*RRB*RRC/RRD)
      TH1T1 = .5*(TH1A+TH1B+TH1C-TH1D)
      COT11 = COS(TH1T1)
      SIT11 = SIN(TH1T1)
      F2CO = RR1*(XRR*COT11-X99*SIT11)-A_*A1
      F3CO = RR1*(XRR*SIT11+X99*COT11)+(((X
      IF (IJ.EQ.7) F(2) = -F2CO
      IF (IJ.EQ.7) F(3) = -F3CO
      IF (IJ.EQ.8) GO TO 340
      IF (IJ.EQ.9) GO TO 341
      IF (IJ.EQ.10) GO TO 342
      IF (IJ.EQ.11) GO TO 343
      IF (IJ.EQ.12) GO TO 344
      IF (IJ.EQ.13) GO TO 345
      IF (IJ.EQ.14) GO TO 346
      IF (IJ.EQ.15) GO TO 347
      TA23 =  TAN(YYS(5)+3A99A)
      XCXS= XRRI(1)*COT11 - X99I(1)*SIT11
      XSXC= XRRI(1)*SIT11 + X99I(1)*COT11
      P(2,5) = -RR1*TA26*(CXS
      P(2,5) = P(2,5)/PAI
      P(3,5) = -RR1*TA23*(SXC
      P(3,5) = P(3,5)/PAI*TA23
      BPY=2.*PAI*(1.+YYS(5))
      P(2,6)=RR1*(XRRI(1)*COT11-X99I(1)*SITH1)/BPY
      P(3,6)=RR1*(XRRI(1)*SIT11+X99I(1)*COT11)/BPY
      P(2,7) = RR1*XCXS/(PAI*YYS(7))                                    C
```

```
      R(3,7) = RR1*XSXG/(PAI+YXS(7)) - 1./YXS(7)                        C
      IJ = 8
      YXS(1) = X(1)+DELT(1,2)
      GO TO 330
  340 FP2 = F2CO
      FP3 = F3CO
      IJ = 9
      YXS(1) = X(1)-DELT(2,1)
      GO TO 330
  341 P(2,1) = (FP2-F2CO)/(2.*DELT(2,1))
      P(3,1) = (FP3-F3CO)/(2.*DELT(2,1))
      YXS(1) = X(1)
      YXS(2) = X(2)+DELT(2,2)
      IJ = 10
      GO TO 330
  342 FP2 = F2CO
      FP3 = F3CO
      YXS(2) = X(2)-DELT(2,2)
      IJ=11
      GO TO 330
  343 P(2,2) = (FP2-F2CO)/(2.*DELT(2,2))
      P(3,2) = (FP3-F3CO)/(2.*DELT(2,2))
      YXS(2) = X(2)
      YXS(3) =   X(3)+DELT(2,3)
      IJ = 12
      GO TO 330
  344 FP2 = F2CO
      FP3 = F3CO
      YXS(3) = X(3)-DELT(2,3)
      IJ = 13
      GO TO 330
  345 P(2,3) = (FP2-F2CO)/(2.*DELT(2,3))
      P(3,3) = (FP3-F3CO)/(2.*DELT(2,3))
      YXS(4) = X(4)+DELT(2,4)
      YXS(3)=X(3)
      IJ=14
      GO TO 330
  346 FP2=F2CO
      FP3=F3CO
      YXS(4) = X(4)-DELT(2,4)
      IJ = 15
      GO TO 330
  347 P(2,4) = (FP2-F2CO)/(2.*DELT(2,4))
      P(3,4) = (FP3-F3CO)/(2.*DELT(2,4))
      YXS(4)=X(4)
C-----F(4)-----------------------------------------------------------------
      IJ=16
      YXS(1)=X(1)+DELT(4,1)
  199 CALL DFSI42(AVS2)
      IF(IJ.EQ.16) GO TO 513
      IF(IJ.EQ.17) GO TO 514
      IF(IJ.EQ.18) GO TO 515
      IF(IJ.EQ.19) GO TO 515
      IF(IJ.EQ.20) GO TO 516
      IF(IJ.EQ.21) GO TO 517
      IF(IJ.EQ.22) GO TO 518
      IF(IJ.EQ.23) GO TO 521
      IF(IJ.EQ.24) GO TO 522
      IF(IJ.EQ.25) GO TO 523
      IF(IJ.EQ.26) GO TO 524
```

```
      IF(IJ.EQ.251) GO TO 5241
      IF(IJ.EQ.262) GO TO 6242
      IF (IJ.EQ.271) GO TO 5251                                        C
      IF (IJ.EQ.272) GO TO 5252                                        C
  513 ANSP=ANS2
      IJ=17
      YXS(1)=X(1)-DELT(4,1)
      GO TO 199
  614 ANS2=ANS2
      IJ=18
      P(4,1)=-(ANSP-ANSQ)/(2.*DELT(4,1))
      YXS(1)=X(1)
      GO TO 199
  575 ANSF=ANS2
      F(4)=-(3135-ANSF)
      IJ=19
      YXS(2)=X(2)+DELT(4,2)*ABS(X(2))
      GO TO 199
  515 ANSPP=ANS2
      IJ=20
      YXS(2)=X(2)-DELT(4,2)*ABS(X(2))
      GO TO 199
  516 ANSGG=ANS2
      P(4,2)=-(ANSPP-ANSGG)/(2.*DELT(4,2)*ABS(X(2)))
      YXS(2)=X(2)
      IJ=21
      YXS(3)=X(3)+DELT(4,3)*X(3)
      GO TO 199
  517 ANS1P=ANS2
      IJ=22
      YXS(3)=X(3)-DELT(4,3)*X(3)
      GO TO 199
  518 ANS1G=ANS2
      P(4,3)=-(ANS1P-ANS1G)/(2.*DELT(4,3)*X(3))
      YXS(3)=X(3)
      IJ=23
      YXS(4)=X(4)+DELT(4,4)*ABS(X(4))
      GO TO 199
  521 ANA=ANS2
      IJ=24
      YXS(4)=X(4)-DELT(4,4)*ABS(X(4))
      GO TO 199
  522 ANB=ANS2
      P(4,4)=-(ANA-ANB)/(2.*DELT(4,4)*ABS(X(4)))
      YXS(4)=X(4)
      IJ=25
      YXS(5)=X(5)+DELT(4,5)
      GO TO 199
  523 BNA=ANS2
      IJ=26
      YXS(5)=X(5)-DELT(4,5)
      GO TO 199
  524 BNB=ANS2
      P(4,5)=-(BNA-BNB)/(2.*DELT(4,5))
      YXS(5)=X(5)
      FFF4=F(4)
      YXS(5) = X(5)
      YXS(6)=X(6)+DELT(4,5)
      IJ=251
      GO TO 199
```

```
 5241 BNA=ANS2
      IJ=262
      YXS(6)=X(6)-DELT(4,6)
      GO TO 199
 5242 BNB=ANS2
      P(4,6)=-(BNA-BNB)/(2.*DELT(4,6))
      YXS(6)=X(6)
      IJ=271                                                          C
      Y(S(7)=X(7)+DELT(4,7)                                           C
      GO TO 199                                                       C
 5251 BNA=ANS2                                                        C
      YXS(7)=X(7)-DELT(4,7)                                           C
      IJ=272                                                          C
      GO TO 199                                                       C
 5252 BNB=ANS2                                                        C
      P(4,7)=-(BNA-BNB)/(2.*DELT(4,7))                                C
      YXS(7)=X(7)                                                     C
C-----F(5) AND F(7)-------------------------------------------------------
C   THIS SUBROUTINE FINDS THE END POINT OF CAVITY.
      IJ = 27
  815 CALL CAVITY (XCEND,YCEND)
C F(7)=YCEND - FUNCTION(XCEND) = 0 TO BE SATISFIED                    C
      IS1I2 = 3                                                       C
      CALL SHAPE(XCEND,YUPPER,BETA,IS1I2)                             C
      IF(IJ.EQ.27) GO TO 820
      IF(IJ.EQ.29) GO TO 821
      IF (IJ.EQ.29) GO TO 822
      IF (IJ.EQ.30) GO TO 823
      IF (IJ.EQ.31) GO TO 824
      IF (IJ.EQ.32) GO TO 825
      IF (IJ.EQ.33) GO TO 826
      IF (IJ.EQ.34) GO TO 827
      IF(IJ.EQ.341) GO TO 830
      IF (IJ.EQ.35) GO TO 828
      IF (IJ.EQ.36) GO TO 829
      IF(IJ.EQ.37) GO TO 840
      IF(IJ.EQ.38) GO TO 841
      IF (IJ.EQ.60) GO TO 1979                                        C
      IF (IJ.EQ.61) GO TO 1980                                        C
  820 F(5)=-(XCEND-CAVLEN)
      F(7) = -(YCEND-YUPPER)                                          C
      IJ = 29
      YXS(1) = X(1)+DELT(5,1)
      GO TO 815
  821 ANP=XCEND
      ANP7=YCEND-YUPPER                                               C
      IJ = 29
      YXS(1) = X(1)-DELT(5,1)
      GO TO 815
  822 P(5,1)=(ANP-XCEND)/(2.*DELT(5,1))
      ANQ7=YCEND-YUPPER                                               C
      P(7,1) = (ANP7-ANQ7)/(2.*DELT(5,1))                             C
      YXS(1) = X(1)
      YXS(2) = X(2)+DELT(5,2)*ABS(X(2))
      IJ = 30
      GO TO 815
  823 ANP=XCEND
      ANP7=YCEND-YUPPER                                               C
      YXS(2) = X(2)-DELT(5,2)*ABS(X(2))
      IJ = 31
```

```
      GO TO 815
  824 P(5,2)=(ANP-XCEND)/(2.*DELT(5,2)*ABS(X(2)))
      ANG7=YCEND-YUPPER                                                 C
      P(7,2) = (ANP7-ANG7)/(2.*DELT(5,2)*ABS(X(2)))                     C
      YXS(2) = X(2)
      IJ = 32
      YXS(3) = X(3)+DELT(5,3)*X(3)
      GO TO 815
  825 ANP=XCEND
      ANP7=YCEND-YUPPER                                                 C
      YXS(3) = X(3)-DELT(5,3)*X(3)
      IJ = 33
      GO TO 815
  826 P(5,3)=(ANP-XCEND)/(2.*DELT(5,3)*X(3))
      ANG7=YCEND-YUPPER                                                 C
      P(7,3) = (ANP7-ANG7)/(2.*DELT(5,3)*X(3))                          C
      IJ = 34
      YXS(3) = X(3)
      YXS(4) = X(4)+DELT(5,4)*ABS(X(4))
      GO TO 815
  827 ANP=XCEND
      ANP7=YCEND-YUPPER                                                 C
      YXS(4) = X(4)-DELT(5,4)*ABS(X(4))
      IJ=341
      GO TO 815
  830 CONTINUE
      P(5,4)=(ANP-XCEND)/(2.*DELT(5,4)*ABS(X(4)))
      ANG7=YCEND-YUPPER                                                 C
      P(7,4) = (ANP7-ANG7)/(2.*DELT(5,4)*ABS(X(4)))                     C
      YXS(4) = X(4)
      YXS(5) = X(5)+DELT(5,5)
      IJ = 35
      GO TO 815
  828 ANP=XCEND
      ANP7=YCEND-YUPPER                                                 C
      YXS(5) = X(5)-DELT(5,5)
      IJ =36
      GO TO 815
  829 P(5,5)=(ANP-XCEND)/(2.*DELT(5,5))
      ANG7=YCEND-YUPPER                                                 C
      P(7,5) = (ANP7-ANG7)/(2.*DELT(5,5))                               C
      YXS(5)=X(5)
      YXS(6)=X(5)+DELT(5,5)
      IJ=37
      GO TO 815
  840 ANP=XCEND
      ANP7=YCEND-YUPPER                                                 C
      YXS(6)=X(5)-DELT(5,5)
      IJ=38
      GO TO 815
  841 P(5,6)=(ANP-XCEND)/(2.*DELT(5,6))
      YXS(6)=X(5)
      ANG7=YCEND-YUPPER                                                 C
      P(7,6) = (ANP7-ANG7)/(2.*DELT(5,6))                               C
      YXS(7)=X(7)+DELT(5,7)                                             C
      IJ=50                                                             C
      GO TO 815                                                         C
 1979 ANP=XCEND                                                         C
      ANP7=YCEND-YUPPER                                                 C
      YXS(7) = X(7) - DELT(5,7)                                         C
```

```
      IJ=51                                                          C
      GO TO 815                                                      C
 1930 P(5,7)=(ANP-XCEND)/(2.*DELT(5,7))                              C
      ANS7=YCEND-YUPPER                                                **
      P(7,7) = (ANP7-ANS7)/(2.*DELT(5,7))                            C
      YXS(7)=X(7)                                                    C
C---------P(6)--------
      IJ=40
  850 CALL OFSI45(ANS5)
      IF(IJ.EQ.40) GO TO 851
      IF(IJ.EQ.41) GO TO 852
      IF(IJ.EQ.42) GO TO 853
      IF(IJ.EQ.43) GO TO 854
      IF(IJ.EQ.44) GO TO 855
      IF(IJ.EQ.45) GO TO 856
      IF(IJ.EQ.46) GO TO 857
      IF(IJ.EQ.47) GO TO 858
      IF(IJ.EQ.48) GO TO 859
      IF(IJ.EQ.49) GO TO 860
      IF(IJ.EQ.50) GO TO 861
      IF(IJ.EQ.51) GO TO 862
      IF(IJ.EQ.52) GO TO 863
      IF (IJ.EQ.53) GO TO 1864                                       C
      IF (IJ.EQ.54) GO TO 1865                                       C
  851 P(6)=-(ANS5-BIG52)
      IJ=41
      YXS(1)=X(1)+DELT(6,1)
      GO TO 850
  852 ANP=ANS5
      IJ=42
      YXS(1)=X(1)-DELT(6,1)
      GO TO 850
  853 P(6,1)=(ANP-ANS5)/(2.*DELT(6,1))
      YXS(1)=X(1)
      IJ=43
      YXS(2)=X(2)+DELT(6,2)
      GO TO 850
  854 ANP=ANS5
      IJ=44
      YXS(2)=X(2)-DELT(6,2)
      GO TO 850
  855 P(6,2)=(ANP-ANS5)/(2.*DELT(6,2))
      IJ=45
      YXS(2)=X(2)
      YXS(3)=X(3)+DELT(6,3)
      GO TO 850
  856 ANP=ANS5
      IJ=46
      YXS(3)=X(3)-DELT(6,3)
      GO TO 850
  857 P(6,3)=(ANP-ANS5)/(2.*DELT(6,3))
      IJ=47
      YXS(3)=X(3)
      YXS(4)=X(4)+DELT(6,4)
      GO TO 850
  858 ANP=ANS5
      IJ=48
      YXS(4)=X(4)-DELT(6,4)
      GO TO 850
  859 P(6,4)=(ANP-ANS5)/(2.*DELT(6,4))
```

```
      IJ=49
      YXS(4)=X(4)
      YXS(5)=X(5)+DELT(5,5)
      GO TO 850
  850 ANP=ANS5
      IJ=50
      YXS(5)=X(5)-DELT(5,5)
      GO TO 850
  851 P(6,5)=(ANP-ANS5)/(2.*DELT(5,5))
      YXS(5)=X(5)
      YXS(6)=X(6)+DELT(6,6)
      IJ=51
      GO TO 850
  852 ANP=ANS5
      YXS(6)=X(6)-DELT(6,6)
      IJ=52
      GO TO 850
  853 P(6,6)=(ANP-ANS5)/(2.*DELT(6,6))
      YXS(6)=X(6)
      YXS(6)=X(6)+DELT(6,7)                                              C
      IJ=53                                                              C
      GO TO 850                                                          C
 1854 ANP=ANS5                                                           C
      IJ=54                                                              C
      YXS(6)=X(6)-DELT(6,7)                                              C
      GO TO 850                                                          C
 1855 P(6,7)=(ANP-ANS5)/(2.*DELT(6,7))                                   C
      YXS(7)=X(7)                                                        C
      DO 666 IK=1,7                                                      C
  666 WRITE(6,667)(P(IK,J),J=1,7)                                        C
  667 FORMAT(3X,'P(I,J)=',7(E14.7,2X))
      NCAV1=NCAV+1
      DO 253 ICV=1,NCAV1,2
  253 WRITE(6,252) CAVX(ICV),CAVY(ICV)
  252 FORMAT(10X,'CAVX=',F10.5,5X,'CAVY=',F10.5)
      DO 129 ITX=1,7                                                     C
  129 WRITE(6,131) ITX,F(ITX)
  131 FORMAT(1X,24H(,I1,24)=,E14.7)
      DO 132 IUP=1,7                                                     C
      IF(ITERA.LE.3) GO TO 385
      DO 132 IUQ=1,7                                                     C
  132 WRITE(6,133) IUP,IUQ,P(IUP,IUQ)
  133 FORMAT(1X,24P(,I1,1H,,I1,24)=,E14.7)
  385 CONTINUE
      CALL DETERM(P,7,DETB)                                              C
      DO 25 IDET=1,7                                                     C
      DO 26 LPG=1,7                                                      C
      Q(LPG,IDET)=P(LPG,IDET)
   26 P(LPG,IDET)=F(LPG)
      CALL DETERM(P,7,DETE)                                              C
      IF(IDET.EQ.1) DELB=DETE/DETB
      IF(IDET.EQ.2) DELC=DETE/DETB
      IF(IDET.EQ.3) DELD=DETE/DETB
      IF(IDET.EQ.4) DELE=DETE/DETB
      IF(IDET.EQ.5) DELF=DETE/DETB
      IF(IDET.EQ.6) DELG=DETE/DETB
      IF(IDET.EQ.7) DELH=DETE/DETB                                       C
      DO 27 LPG=1,7                                                      C
   27 P(LPG,IDET)=Q(LPG,IDET)
   25 CONTINUE
```

```
      X(1)=X(1)+DELB
      X(2)=X(2)+DELC
      X(3)=X(3)+DELD
      X(4)=X(4)+DELE
      X(5)=X(5)+DELF
      X(6)=X(6)+DELG
      X(7)=X(7)+DELH                                                    C
      DO 60 LMN=1,7                                                     C
   60 WRITE(6,61) LMN,X(LMN)
   61 FORMAT(1X,24HX(,I1,24)=,E14.7)
      ABSB=ABS(DEL_B/X(1))
      ABSC=ABS(DELC/X(2))
      ABSD=ABS(DEL_D/X(3))
      ABSE=ABS(DELE/X(4))
      ABSF=ABS(DEL_F/X(5))
      ABSH=ABS(DEL_H/X(7))                                              C
      ABSG=ABS(DEL_G/X(6))
      KEID=0
      IF(ABSB.LT.STOL) KEID=1
      IF(ABSC.GT.STOL) KEID=0
      IF(ABSD.GT.STOL) KEID=0
      IF(ABSE.GT.STOL) KEID=0
      IF(ABSF.GT.STOL) KEID=0
      IF(ABSG.GT.STOL) KEID=0
      IF(ABSH.GT.STOL) KEID=0                                           C
      IF(KEID.EQ.1) GO TO 35
      I=I+1
      WRITE(6,42) I
   42 FORMAT(20X,14HITERATION NO.=,I2)
      IF(I.EQ.99) GO TO 35
      GO TO 55
   35 IF(I.EQ.99) GO TO 36
      GO TO 38
   36 WRITE(6,37)
   37 FORMAT(1X,34HOXFNEW DID NOT CONVERGE WITHIN 99)
      IF(X(1).LT.SI1) X(1)=SI1
      SI10=X(1)+2.*DG
      IF(X(2).LT.SI10) X(2)=SI10
      SI11=X(2)+2.*DG
      IF(X(3).LT.SI11) X(3)=SI11
      IF(X(5).LE.1.E-3) X(5)=1.E-3
      IF(X(4).LT.SI6)  X(4)=SI6
      SI5=(.5**PAI-GAMMA)*(1.-.02)
      IF(X(5).LT.0.) GO TO 31
      IF(X(5).GT.SI5) X(5)=SI5
      GO TO 32
   31 IF(ABS(X(5)).GT.SI5) X(5)=-SI5
   32 CONTINUE
      IF (X(7).LE.0.) WRITE(6,1122)                                     C
 1122 FORMAT(2X,*----------X(7) BECAME LESS THAN ZERO----------*)        C
   38 RETURN
      END
```

**

```
      SUBROUTINE DFSIM1(ANS,NDF,KCA)
      DIMENSION XST(7)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSS2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFA1,GAMMA
      COMMON       SBETA,III,ICPI,SARCD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(7),     DLE,ERC,YYY,KM,ITERA,SXSID(7),SXSIDD(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XRDJND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TSAUS(100),WGAUS(100),NGAUS
C     NDF    = 0  CALLED FROM FIINT.
C     NDF    = 1  CALLED FROM RMINT FOR REAL PART.
C     NDF    = 2  CALLED FROM RMINT FOR IMAG. PART.
C     NDF    = 3  CALLED FROM CAVITY DXFNEW AT F(5)
      IF (ICPI.EQ.0) GO TO 9
      DO 10 IG = 1,7                                                    C
   10 XST(IG) = XSN(IG)
      GO TO 12
    9 DO 11 IH = 1,7                                                    C
   11 XST(IH) = YXS(IH)
   12 CONTINUE
      IF(ITERA.EQ.1) GO TO 222
      GO TO 223
  222 DO 224 ILK = 1,LPM
  224 BETAN(ILK) = SBETA
  223 CONTINUE
      CSPACE = (1.+XST(1))/FLOAT(LPK)
      FSPACE = CSPACE/FLOAT(LPM-LPK)
      LPM3=LPM-3
      XBET = -1.+CSPACE+FLOAT(LPK-1)
      XSI1=-1.+CSPACE
      BE1 = BETAN(2)
      AP1 = (XSI1-XST(2))/((XSI1+1.)*(XST(1)-XSI1)*(XSI1-XST(3)))
      AP1S = SQRT(AP1)
      F3 = BE1*AP1S
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
      PLM = XSI1 -XX1
      PLM2 = PLM**2
      PLMA = PLM2+YY12
      PXSR = PLM/PLMA
      PXSI = YY1/PLMA
      IF(NDF.EQ.1) F3 = F3*PXSR
      IF(NDF.EQ.2) F3 = F3*PXSI
      IF(NDF.EQ.3) F3=F3/((SI1-XCA)
      ANSA=0.
      DO 1 I = 2,LPM3,2
      F1 = F3
      SPACE = CSPACE
      IF (I.GE.LPK) GO TO 30
      XSI2 = -1.+SPACE*FLOAT(I)
      XSI3 = XSI2+SPACE
      GO TO 31
   30 SPACE  = FSPACE
      XSI2 = XBET+SPACE*FLOAT(I-LPK+1)
```

```
      XSI3 = XSI2+SPACE
   31 BE2 = BETAN(I+1)
      BE3 = BETAN(I+2)
      AP2 = (XSI2-XST(2))/((XSI2+1.)*(XST(1)-XSI2)*(XSI2-XST(3)))
      AP3 = (XSI3-XST(2))/((XSI3+1.)*(XST(1)-XSI3)*(XSI3-XST(3)))
      AP2S = SQRT(AP2)
      AP3S = SQRT(AP3)
      F2 = BE2*AP2S
      F3 = BE3*AP3S
      HA2 = XSI2-XX1
      HA22 = HA2**2
      HB = HA22+YY12
      HCR2 = HA2/HB
      HCI2 = YY1/HB
      HA3 = XSI3-XX1
      HA32 = HA3**2
      HD=HA32+YY12
      HCR3 = HA3/HD
      HCI3 = YY1/HD
      IF(NOF.EQ.1) F2 = F2*HCR2
      IF(NOF.EQ.1)  F3 = F3*HCR3
      IF (NOF.EQ.2)  F2 = F2*HCI2
      IF(NOF.EQ.2)  F3 = F3*HCI3
      IF (NOF.EQ.3)  F2 = F2/(XSI2-XCA)
      IF(NOF.EQ.3)  F3 = F3/(XSI3-XCA)
      FSUM = (F1+4.*F2+F3)*SPACE/3.
      ANSA = ANSA+FSUM
    1 CONTINUE
      SQ1 = SQRT((-1.-XST(2))/(-1.-XST(3)))
      SQ2 = SQRT(XST(1)+1.)
      SQ3 = SQRT((XST(1)-XST(2))/(XST(1)-XST(3)))
      ANT1 = BETAN(1)*2.*SQRT(SPACE)*SQ1/SQ2
      ANT2 = BETAN(LPM)*2.*SQRT(SPACE)*SQ3/SQ2
      APLA = -1.-XX1
      APLA2 = APLA**2
      APLB = XST(1)-XX1
      APLB2 = APLB**2
      IF(NOF.EQ.1) ANT1 = ANT1*APLA/(APLA2+YY12)
      IF (NOF.EQ.2 ) ANT1 = ANT1*YY1/(APLA2+YY12)
      IF (NOF.EQ.1) ANT2 = ANT2*APLB/(APLB2+YY12)
      IF (NOF.EQ.2) ANT2 = ANT2*YY1/(APLB2+YY12)
      IF (NOF.EQ.3) ANT1 = ANT1/(-1.-XCA)
      IF (NOF.EQ.3) ANT2 = ANT2/(XST(1)-XCA)
      ANS  = ANSA+ANT1+ANT2
      RETURN
      END


$$
```

```
      SUBROUTINE DFSIM2(ANS2)
      DIMENSION X(3),XIT(3),YY(3),XITC(3),EXU(3),FCN3(3),XST(7)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSS2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),IGHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALPHA1,GAMMA
      COMMON        SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDJ,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(7),      CLE,ERC,YYY,XM,ITERA,SXSIO(7),SXSIOO(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XRDJN2,A2AA,B233,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TSAJS(100),DSAJS(100),NSAUS
      DO 13 IS=1,7                                                          C
   13 XST(IS)=YXS(IS)
      PAI=3.141592653
      CCC1=ALOG(1.+XST(6))/(2.*PAI)
      UU2=COS(ALPHA1+GAMMA)/COS(XST(5)+GAMMA)/XST(7)                        C
      XXXX=ALOG(UU2)
      CSPACE=(1.+ XST(1))/FLOAT(LPK)
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(LPM-LPK)
      HFSPAC=0.5*FSPACE
      XBET=-1.+CSPACE*FLOAT(LPK-1)
      CDE=COS(DELTA)
      SDE=SIN(DELTA)
      SA=XST(1)-XST(4)*SDE
      SB=XST(4)*CDE
      PPP=CDE/(SA**2+SB**2)
      FCN3(3)=DSAP*PPP*XST(1)/(PAI*SQRT(1.+XST(6)))
      LPKI=LPM-LPK+1
      DO 1 IP=1,LPM
      IF(IP.EQ.1) GO TO 2
      HSPACE=HFSPAC
      SPACE=FSPACE
      IF(IP.GT.LPK(I) GO TO 30
      X(1)=XST(1)-SPACE*FLOAT(IP-2)
      X(2)=X(1)-HSPACE
      X(3)=X(1)-SPACE
      GO TO 31
   30 HSPACE=HCSPAC
      SPACE=CSPACE
      X(1)=XBET-SPACE*FLOAT(IP-LPK(I-1)
      X(2)=X(1)-HSPACE
      X(3)=X(1)-SPACE
   31 FCN3(1)=FCN3(3)
      NK=3
      IF(IP.EQ.LPM) NK=2
      DO 8 I=2,NK
      IF(IJ.GE.23) GO TO 5
      GO TO 7
    5 IF(I.EQ.2) XII(2)=XITM(LPM-IP+1)
      IF(I.EQ.3) XII(3)=XITN(LPM-IP+1)
      GO TO 5
    7 CONTINUE
      YY(I)=X(I)
    8 DFSIM3 CALCULATE 31 .
      CALL DFSIM3(YY(I),XITC(I),IP,I)
      XII(I)=XITC(I)
```

```
      IF(IJ.EQ.13) GO TO 5
      GO TO 5
    5 IF(I.EQ.2) XITN(LPM-IP+1)=XIT(I)
      IF(I.EQ.3) XITN(LPM-IP+1)=XIT(I)
    5 CONTINUE
      EXU(I)=EXP(-XIT(I))
      GO=X(I)-XST(4)*SDE
      GD=XST(4)*CDE
      PXA=GO**2+GD**2
      DWDX=DGAP*X(I)*CDE/(PXA*PAI)
      FCN3(I)=EXU(I)*DWDX/UU2
      IF(X(I).LE.0.) FCN3(I)=-FCN3(I)
    6 CONTINUE
C CHECK IF FCN3(I) IS ALWAYS POSITIVE.
      IF(IP.EQ.LPM) GO TO 20
      GO TO 21
   20 PP3=CDE/((-1.-XST(4)*SDE)**2+(XST(4)*CDE)**2)
      FF3=DGAP*PP3/PAI
      FCN3(3)=FF3
   21 SUM=(FCN3(1)+FCN3(2)*4.+FCN3(3))*HSPACE/3.
      ANS2=ANS2+SUM
      IF(IJ.EQ.13) SARC(LPM-IP+1)=ANS2
      GO TO 1
    2 SARC(LPM)=0.
      ANS2=0.
    1 CONTINUE
C XITN(LPM)=G1 AT POINT B.
C XINT(1)=G1 AT POINT X=1.
      XITN(LPM)=CCC1-KK<</PAI
      XITN(1)=0.
      RETURN
      END


$$
```

```
      SUBROUTINE DFSIM3(Y,XXII,IP,I)
      DIMENSION XST(7),FA(200)
      COMMON YCCC,SBETA2
      COMMON XIIM(200),XIIN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),IGHAIP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DDAP,ALPAI,GAMMA
      COMMON        SBETA,XXM,ICPI,SARCD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSV(7),     CLE,ERC,YYY,XM,ITERA,SXSIO(7),SXSIOO(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XRDJND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
C     FOUR INTEGRALS TO BE EVALUATED BEFORE XI IS OBTAINED.
C     NOTE THAT PREVIOUSLY ONLY ONE  SINGULAR INTEGRAL WAS
C     CALCULATED IN SCASCA) AND CASCADE.
C     SEE THE NOTE OF TO 3951 FOR FOUR INTEGRALS, OUT OF WHICH
C     TWO ARE OF SINGULAR TYPE.
      IF(ICPI.EQ.0) GO TO 9
      DO 11 ISI=1,7                                                     C
   11 XST(ISI)=XSV(ISI)
      GO TO 12
    9 DO 13 JTJ=1,7                                                     C
   13 XST(JTJ)=YXS(JTJ)
   12 PAI=3.141592653
      CCC1=ALOG(1.+XST(6))/(2.*PAI)
C-----FIRS  I1-------
      IF (ITERA.EQ.1) GO TO 60
      GO TO 61
   60 CONTINUE
      DO 62 IZU = 1,LPM
      BETAN(IZU) = SBETA
      BETAM(IZU) = SBETA
   62 CONTINUE
   61 CONTINUE
      CSPACE=(1.+ XST(1))/FLOAT(LPK)
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(LPM-LPK)
      HFSPAC=0.5*FSPACE
      XBET=-1.+CSPACE*FLOAT(LPK-1)
      AB2=SQRT(XST(1)+1.)
      AB3=SQRT((1.+Y)*(XST(1)-Y))
      AB6 = SQRT((XST(3)-Y)/(XST(2)-Y))
      AB3 = AB3*AB6
      IJ2=LPM-IP+1
      IU3=1
      IF(I.EQ.3) IU3=LPM-IP+1
      IF(I.EQ.0) IU3=IP
      BEC=BETAN(IU3)
      IF(I.EQ.2) BEC=BETAM(IU2)
      FAA=BEC/AB3
      LPM1=LPM-1
      DO 1 IW=2,LPM1
      SPACE=CSPACE
      IF(IW.GT.LPK) GO TO 65
      XSK=-1.+SPACE*FLOAT(IW-1)
      GO TO 66
   65 SPACE=FSPACE
      XSK=XBET+ SPACE*FLOAT(IW-LPK)
```

```
46 IF(I.EQ.2) GO TO 6
   IF(IW.EQ.IU3) GO TO 1
 6 FS=SQRT((1.+XSK)*(XST(1)-XSK))
   FSA1 = SQRT((XST(3)-XSK)/(XST(2)-XSK))
   FS = FS*FSA1
   FA(IW)=(BETAN(IW)/FS-FAA)/(XSK-Y)
 1 CONTINUE
   IF(I.EQ.2) GO TO 30
   XP1=-1.+HCSPAC
   XP2=XP1+CSPACE
   XP4=XST(1)-HFSPAC
   XP3=XP4-FSPACE
   FS1=BETAM(1)/ SQRT((1.+XP1)*(XST(1)-XP1))
   FS2=BETAM(2)/ SQRT((1.+XP2)*(XST(1)-XP2))
   FS3=BETAM(LPM-2)/ SQRT((1.+XP3)*(XST(1)-XP3))
   FS4=BETAM(LPM-1)/ SQRT((1.+XP4)*(XST(1)-XP4))
   FSA1 = SQRT((XST(2)-XP1)/(XST(3)-XP1))
   FSA2 = SQRT((XST(2)-XP2)/(XST(3)-XP2))
   FSA3=SQRT((XST(2)-XP3)/(XST(3)-XP3))
   FSA4=SQRT((XST(2)-XP4)/(XST(3)-XP4))
   FS1=FS1*FSA1
   FS2=FS2*FSA2
   FS3=FS3*FSA3
   FS4=FS4*FSA4
   FP1=(FS1-FAA)/(XP1-Y)
   FP2=(FS2-FAA)/(XP2-Y)
   FP3=(FS3-FAA)/(XP3-Y)
   FP4=(FS4-FAA)/(XP4-Y)
   IF(IU3.EQ.2) GO TO 21
   IF(IU3.EQ.LPM1) GO TO 22
   IF(IU3.EQ.LPK) GO TO 51
   FA(IU3)=0.5*(FA(IU3-1)+FA(IU3+1))
   GO TO 30
51 BETO=2.*BETAN(LPK)-BETAN(LPK+1)
   XOA=XBET-FSPACE
   FPW=BETO/SQRT((1.+XOA)*(XST(1)-XOA))
   FPWA = SQRT((XST(2)-XOA)/(XST(3)-XOA))
   FPWA=FPWA*FPW
   FLPK=(FPW-FAA)/(XOA-Y)
   FA(IU3)=0.5*(FA(IU3+1)+FLPK)
   GO TO 30
21 FA(IU3)=(FP1+FP2)/2.
   GO TO 30
22 FA(IU3)=(FP3+FP4)/2.
30 XI=0.
   LPM3=LPM-3
   SPACE=CSPACE
   DO 15 JA=2,LPM3,2
   IF(JA.GE.LPK) SPACE=FSPACE
15 XI=XI+(FA(JA)+4.*FA(JA+1)+FA(JA+2))*SPACE/3.
   IF(I.EQ.2) GO TO 35
   XI23=0.5*HCSPAC*(FP1+FA(2))+(FA(LPM-1)+FP4) *0.5*HFSPAC
   XKI=41.
   KJ=39
   LPMA=LPM-5
   IF(IU3.GE.LPMA) XKI=201.
   IF(IU3.GE.LPMA) KU=199
   BDZ=(BETAM(1)-BETAM(1))/XKI
   BDY=(BETAM(LPM)-BETAM(LPM1))/(KI
   HFF=HFSPAC/XKI
```

```
      HF4=HCSPAC/XXI
      FT3=FP1
      FJ3=FP4
      XI4=0.
      XI1=0.
      DO 202 ITM=1,XJ,2
      FT1=FT3
      FJ1=FJ3
      XM2=XST(1)-HFSPAC+HFF*FLOAT(ITM)
      XM3=XM2+HFF
      XT2=-L.+HCSPAC-HF4+F_OAT(ITM)
      XT3=XT2-HF4
      BETA2=BETAM(LPM1)+BJY*F_OAT(ITM)
      BETA3=BETA2+BJY
      BETT2=BETAM(1)-BJZ+F_OAT(ITM)
      BETT3=BETT2-BJZ
      FS2=BETA2/SQRT((1.+XM2)*(XST(1)-XM2))
      FS3=BETA3/SQRT((1.+XM3)*(XST(1)-XM3))
      FV2=BETT2/SQRT((1.+XT2)*(XST(1)-XT2))
      FV3=BETT3/SQRT((1.+XT3)*(XST(1)-XT3))
      FS2A = SQRT((XST(2)-XM2)/(XST(3)-XM2))
      FS3A = SQRT((XST(2)-XM3)/(XST(3)-XM3))
      FV2A = SQRT((XST(2)-XT2)/(XST(3)-XT2))
      FV3A = SQRT((XST(2)-XT3)/(XST(3)-XT3))
      FS2 = FS2*FS2A
      FS3 = FS3*FS3A
      FV2 = FV2*FV2A
      FV3 = FV3*FV3A
      FJ2=(FS2-FAA)/(XM2-Y)
      FJ3=(FS3-FAA)/(XM3-Y)
      FT2=(FV2-FAA)/(XT2-Y)
      FT3=(FV3-FAA)/(XT3-Y)
      XI4=XI4+HFF*(FJ1+FJ2+4.*FJ3)/3.
  202 XI1=XI1+HF4*(FT1+FT2+4.*FT3)/3.
      XA4=BETAN(LPM)*2.*SQRT(HFF)/(AB2*(XST(1)-Y))
      XA4A = SQRT((XST(2)-XST(1))/(XST(3)-XST(1)))
      XA4 = XA4*XA4A
      XI4=XI4+XA4
      XA1=BETAN(1)*2.*SQRT(HF4)/(AB2*(-1.-Y))
      XA1A = SQRT((XST(2)+1.)/(XST(3)+1.))
      XA1 = XA1*XA1A
      XI1=XI1+XA1
      XI=(XI+XI23-XI1+XI4)*AB3/PAI
      XI=XI+BEC*ALOG((XST(1)-Y-HFF)/(1.+Y-HF4))/PAI
      XXI1=-XI
      GO TO 36
   35 XR1=-1.+0.5*HCSPAC
      XR2=XR1+HCSPAC
      XR4=XST(1)-0.5*HFSPAC
      XR3=XR4-HFSPAC
      FT1=0.5*(BETAN(1)+BETAM(1))/ SQRT((1.+XR1)*(XST(1)-XR1))
      FT2=0.5*(BETAM(1)+BETAN(2))/ SQRT((1.+XR2)*(XST(1)-XR2))
      FT3=0.5*(BETAN(LPM-1)+BETAM(LPM-1))/ SQRT((1.+XR3)*(XST(1)-XR3))
      FT4=0.5*(BETAM(LPM-1)+BETAN(LPM))/ SQRT((1.+XR4)*(XST(1)-XR4))
      FT1A = SQRT((XST(2)-XR1)/(XST(3)-XR1))
      FT2A = SQRT((XST(2)-XR2)/(XST(3)-XR2))
      FT3A = SQRT((XST(2)-XR3)/(XST(3)-XR3))
      FT4A = SQRT((XST(2)-XR4)/(XST(3)-XR4))
      FT1 = FT1*FT1A
      FT2 = FT2*FT2A
```

```
      FT3 = FT3+FT3A
      FT4 = FT4+FT4A
      FR1=(FT1-FAA)/(XR1-Y)
      FR2=(FT2-FAA)/(XR2-Y)
      FR3=(FT3-FAA)/(XR3-Y)
      FR4=(FT4-FAA)/(XR4-Y)
      XIP1=0.5*HCSPAC*(FR1+FR2)+0.5*HFSPAC*(FR3+FR4)
      XIP2=0.25*HCSPAC*(FR2+FA(2))+0.25*HFSPAC*(FA(LPM-1)+FR3)
      XI23=XIP1+XIP2
      XMI=21.
      XMI2=42.
      MJ=21
      M2=MU-2
      LPMA=LPM-3
      IF(IU2.GE.LPMA) XMI=101.
      IF(IU2.GE.LPMA) XMI2=202.
      IF(IU2.GE.LPMA) MU=101
      IF(IU2.GE.LPMA) M2=MJ-2
      BETY=(BETAN(LPM)-BETAN(LPM-1))/(MI2
      BESS=0.5*(BETAN(LPM)+BETAN(LPM-1))
      HSPS=0.5*HFSPAC/XMI
      FQ3=FR4
      BETY1=(BETAM(1)-BETAN(1))/XMI2
      BESS1=0.5*(BETAM(1)+BETAN(1))
      HSPS1=0.5*HCSPAC/XMI
      FQ31=FR1
      XI1=0.
      XI4=0.
      DO 129 IL=1,M2,2
      FQ1=FQ3
      FQ11=FQ31
      X2=XST(1)-HSPS*FLOAT(MJ-IL)
      X3=X2+HSPS
      X21=-1.+HSPS1*FLOAT(MJ-IL)
      X31=X21-HSPS1
      BETA2=BESS+BETY*FLOAT(IL)
      BETA3=BESS+BETY*FLOAT(IL+1)
      BETA21=BESS1-BETY1*FLOAT(IL)
      BETA31=BETA21-BETY1
      FJ21=BETA21/ SQRT((1.+X21)*(XST(1)-(21))
      FJ31=BETA31/ SQRT((1.+X31)*(XST(1)-X31))
      FJ21A = SQRT((XST(2)-X21)/(XST(3)-X21))
      FJ31A = SQRT((XST(2)-X31)/(XST(3)-X31))
      FJ21 = FJ21*FJ21A
      FJ31 = FJ31*FJ31A
      FQ21=(FJ21-FAA)/(X21-Y)
      FQ31=(FJ31-FAA)/((31-Y)
      FJ2=BETA2/ SQRT((1.+X2)*(XST(1)-X2))
      FJ3=BETA3/ SQRT((1.+(3)*(XST(1)-X3))
      FJ2A = SQRT((XST(2)-X2)/(XST(3)-X2))
      FJ3A = SQRT((XST(2)-(3)/((ST(3)-X3))
      FJ2 = FJ2*FJ2A
      FJ3 = FJ3*FJ3A
      FQ2=(FJ2-FAA)/(X2-Y)
      FQ3=(FJ3-FAA)/(X3-Y)
      XI1=XI1+HSPS1*(FQ11+FQ21+4.*FQ31)/3.
  129 XI4=XI4+HSPS*(FQ1+4.*FQ2+FQ3)/3.
      XIA=2.*SQRT(HSPS)*BETAN(LPM)/(A32*((ST(1)-Y))
      XIAA = SQRT((XST(2)-XST(1))/(XST(3)-XST(1)))
      XIA = XIA*XIAA
```

```
      XI4=XI4+XIA
      XIB=2.*SQRT(HSP61)*BETAN(1)/(AB2*(-1.-Y))
      XI9A = SQRT((XST(2)+1)/(XST(5)+1.))
      XI9 = XIB*XI9A
      XI1=XI1+XI3
      XI=(XI+XI1+XI23+XI4)*AB3/PAI
      XI=XI+BEC*ALOG((XST(1)-Y-HSP5)/(1.+Y-HSP61))/PAI
      XXI1=XI
   36 CONTINUE
C-------I2----------
C----------IF Y IS LESS THAN ZERO, THIS IS A
C-----REGULAR INTEGRAL, WHILE Y .GE. 0, THIS IS A
C-----SINGULAR INTEGRAL.
C     BUT THIS IS TREATED AS A SINGULAR INTEGRAL ANYWAY
      ISIC=3
      XCA=Y
      CALL IC2(SR,SM,XCA,ISIC)
      XXI2=SR
      ARGL=(XST(1)      -Y)/Y
      IF (ARGL.LT.0.) ARGL=-ARGL
      XXI2=XXI2*AB3*ALOG(ARGL)
      XXI2=-XXI2
C-----I3----------
C     USE CHEBYSHEV-GAUSS QUADRATURE.
C     AJ(I) ARE ALREADY CALCULATED IN SUBROUTINE FIINTL
C     AND PASSED ONTO HERE BY COMMON STATEMENT.
      XXI3 = 0.
      BPC5 = (XST(1)+XST(2))*.5
      CMB5 = (XST(2)-XST(1))*.5
      A31 = (BPC5+1.)/CMB5
      A32 = (-BPC5+XST(3))/CMB5
      DO 120 ISUM = 1,NCHBY
      HA1 = 1.-AJ(ISUM)
      HA2 = (AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SHA2 = SQRT(HA2)
      F3I3 = HA1/SHA2
      F3AI3 = CMB5*AJ(ISUM)+BPC5-Y
  120 XXI3 = XXI3+F3I3/F3AI3
      XXI3 = XXI3*PAI/NCHBY
      JJ22 = COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)/XST(7)                    C
      HX3 = CCC1-ALOG(JJ22)/PAI
      XXI3 = XXI3*AB3*HX3
C-----I4----------
C     USE CHEBYSHEV-GAUSS QUADRATURE FORMULA---
C------BBETAN2(I) ARE ALREADY CALCULATED IN
C     SUBROUTINE FIINTL AND PASSED ONTO HERE BY
C     COMMON STATEMENT.
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      XXI4 = 0.
      DO 130 ISUM = 1,NCHBY
      RAX = (BBTAN2(ISUM)+PAI)*(1.+AJ(ISUM))
      RBX = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
      SRBX = SQRT(RBX)
      RCX = RAX/SRBX
      RDX = FMC5*AJ(ISUM)+FPC5-Y
  130 XXI4 = XXI4 + RCX/RDX
      XXI4 = XXI4*PAI/NCHBY
```

```
      XXI4 = -XXI4*A83/PAI
      XXII = XXII+XXI2+XXI3+XXI4
      IWRIT1=2
      IWRIT2=30
      IWRIT3=60
      IF (IJ.EQ.19.AND.IP.EQ.IWRIT1) WRITE(6,55) XXI1,XXI2,XXI3 ,XXI4,IP
      IF (IJ.EQ.19.AND.IP.EQ.IWRIT2) WRITE(6,55) (XI1,XXI2,XXI3,XXI4,IP
      IF (IJ.EQ.19.AND.IP.EQ.IWRIT3) WRITE (6,55) XXI1,XXI2,XXI3,XXI4,IP
   55 FORMAT (1X,'---II,I2,I3,I4 OF F(4) ARE----',4(E14.7,2X),2X,
     A,IP=',I4)
      RETURN
      END


"
```

```
      SUBROUTINE DFSI45(ANS5)
      DIMENSION S2SR(101),S2(ER(101),XST(7)
      COMMON YCCC,SBETA2
      COMMON XII4(200),XIIN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFAI,GAMMA
      COMMON        SBETA,XK4,ICPI,SARCOD(513)
      COMMON IOJ,,XA,XB,XC,TANG,EP,YC,YR,JBIGS,KLBIGS,BIGS,SMALS,OSS
      COMMON XSN(7),      CLE,ERC,YMY,XM,IIERA,SXSIO(7),SXSIOO(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XRDJND,A2AA,B233,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TSAUS(100),WGAJS(100),NGAUS
      PAI=3.141592654
C     THIS SUBROUTINE CALLED FROM DEFNEW.
C     USE SIMPSONYS RULE.
      DO 1 IMD = 1,7                                                    C
    1 XST(IMD) = YXS(IMD)
      CDE = COS(DELTA)
      SDE = SIN(DELTA)
C  NS2 SHOULD HAVE A FACTOR OF 4.
C NS2=LPM+LPM2
      NS21 = NS2+1
      NS2A = NS2-1
      S2GAP = (XST(3)-XST(2))/NS2
      JJ2 = COS(ALFAI+GAMMA)/COS(XST(5)+GAMMA)/XST(7)                   C
      DO 2 IS2 = 1,NS21
      XS2 = XST(2)+S2GAP*(IS2-1)
      XCO = XS2*CDE
      XMAS = XS2-XST(4)*SDE
      XMAS2 = XMAS**2
      ASD = XST(4)*CDE
      ASD2 = ASD**2
      DWDX = DGAP*XKD/((XMAS2+ASD2)*PAI)
      IF (IS2.EQ.1) GO TO 3
      IF (IS2.EQ.NS21) GO TO 4
      CALL G2 (XS2,ANSG2,IS2)
C     G2 CALCULATES G2 WITH XSI GIVEN.
      EG2 = EXP(-ANSG2)
      IF(IJ.EQ.40) ANSG2S(IS2)=ANSG2
      S2KER(IS2) = EG2*DWDX/JJ2
      GO TO 2 .
    3 CONTINUE
      S2KER(1) = DWDX/SQRT(1.+XST(6))
      ANSG2S(IS2)=ALOG(SQRT(1.+XST(6))/JJ2)
      GO TO 2
    4 CONTINUE
      S2KER(NS21) = DWDX/JJ2
      ANSG2S(IS2)=0.
    2 CONTINUE
      S2SR(1) = 0.
      DO 10 JS2 = 1,NS2A,2
   10 S2SR(JS2+2) = S2SR(JS2)
     1+(S2KER(JS2)+4.*S2KER(JS2+1)+S2(ER(JS2+2))*S2GAP/3.
      IF(IJ.NE.40) GO TO 41
      SARC2(1)=0.
      DO 50 ISARC=2,NS2,2
   50 S2SR(ISARC)=.5*(S2SR(ISARC-1)+S2SR(ISARC+1))
      DO 30 ISARC=1,NS21
```

```
30 SARC2(ISARC)=S2SR(ISARC)
40 CONTINUE
   ANS5 = S2SR(NS21)
   RETURN
   END
```

```
      SUBROUTINE IC2(SR,SI,XCA,ISIC)
      DIMENSION XST(7)
      COMMON YCCC,SBETA2
      COMMON XIF1(200),XIFN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCA/,LPMM,NS2
      COMMON AJ(100),ISMAX,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALPAI,SAMM
      COMMON        SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSV(7),     CLE,ERC,YYY,XM,ITERA,SXSID(7),SYSIDD(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XJX
      COMMON XRDJND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TSAUS(100),YSAUS(100),NSAUS
      DO 1 IPN = 1,7                                                    C
    1 XST(IPN) = YXS(IPN)
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
C     ISIC = 0 FOR RMINT
C          = 1 IN CAVITY OF DFSING FOR F(5) AND IN CAVITY.
C            2 CALLED FROM FINTL FOR F(1).
C            3 FOR L2 OF F(4).
      SR=0.
      SI=0.
      BH=XST(1)*.5
      BHMC=BH-XST(2)
      BHP1=BH+1.
      BHMF=BH-XST(3)
      B11=BHMC/BH
      B12=BHP1/BH
      B13=BHMF/BH
      IF(ISIC.NE.3) GO TO 20
      AP1=(XCA+1.)*(XST(1)-XCA)*(XCA-XST(3))
      AP2=XCA-XST(2)
      APS=SQRT(AP1/AP2)
   20 CONTINUE
      DO 7 ISJM=1,NCHBY
      RA=(AJ(ISJM)+B11) *(AJ(ISJM)+1.)
      RB=(AJ(ISJM)+B12)*(AJ(ISJM)+B13)
      SAB=SQRT(RA/RB)
      SAC=BH*SQRT(1.-AJ(ISJM)**2)/SAB
      XSIP=BH*AJ(ISJM)+BH
      XPXP=XSIP-XX1
      XPXP2=XPXP**2
      RV2=XPXP2+YY12
      RWR=XPYP/RV2
      RWI=YY1/RV2
      IF(ISIC.EQ.1) RWR=1./(XSIP-XCA)
      IF(ISIC.EQ.2) RWR=1.
      IF(ISIC.EQ.3) RWR=(1.-SAC/APS)/( XSIP-XCA)
      SR=SR+SAB*RWR
    7 SI=SI+SAB*RWI
      PAI=3.141592654
      SR=SR*PAI/NCHBY
      SI=SI*PAI/NCHBY
      RETURN
      END
```

```
      SUBROUTINE F1INTL(YINT,KCTRL)
      DIMENSION XST(7)
      COMMON YCCC,SBETA2
      COMMON XITM(200),KITM(200),ANSS2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFA1,GAMMA
      COMMON       SBETA,XKM,ICPI,SARCOD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(7),     DLE,ERC,YYY,XM,ITERA,SXSIO(7),SXSIOO(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,FSAJS(100),WSAJS(100),NGAUS
C     SUBROUTINE F1INTL CALCULATES THE INTEGRALS IN F(1)
C     ISHARP = 0 FOR SHARP L.E.FOILS.
C     ISHARP = 1 FOR ROUNDED L.E.FOILS.
C     IF FOILS HAVE ROUNDED L.E., CHEBYSHEV-GAUSS
C     QUADRATURE
C     QUADRATURE FORMULA CAN NOT BE USED.  SINCE BETA
C     IS NOT A SMOOTH FUNCTION.
C     NCHBY = NUMBER OF CHEBYSHEV-GAUSS QUADRATURE CONTROL POINTS.
      PAI = 3.1415926554
      IF(ICPI.EQ.0) GO TO 9
      DO 70 IQ = 1,7                                                    C
   70 XST(IQ) = XSN(IQ)
      GO TO 12
    9 DO 11 IH = 1,7                                                    C
   11 XST(IH) = YXS(IH)
   12 CONTINUE
    5 DN1 = (XST(1)+1.)*.5
      DN2 = (XST(1)-1.)*.5
      A11 = (DN2-XST(2))/DN1
      A12 = (DN2-XST(3))/DN1
      BC5 = (XST(1)+XST(2))*.5
      CMB5=(XST(2)-XST(1))*.5
      A31 = (BC5+1.)/CMB5
      A32 = (-BC5+XST(3))/CMB5
      FCA5 = (XST(3)-XST(2))*.5
      FC15 = (XST(3)+XST(2))*.5
      A41 = (FC15+1.)/FCA5
      A42 = (FC15-XST(1))/FCA5
      SPACE2 = (XST(3)-XST(2))/LPMM
C     READ LPMM FOR THE SECOND ARC.
      IF(KCTRL.GE.2) GO TO 100
      IF(IJ.GE.2) GO TO 100
      CSPACE = (1.+XST(1))/FLOAT(LPK)
      FSPACE = CSPACE/FLOAT(LPM-LPK)
      IDM = 1
      XCHCK = -1.
      SPACE=CSPACE
      DO 20 ICHBY=1,NCHBY
      NCH=NCHBY-ICHBY+1
      AJ(ICHBY)=COS((2*NCH-1)*PAI/(2*NCHBY))
      XKSI=DN1*AJ(ICHBY)+DN2
      IF(ITERA.EQ.1) GO TO 888
   22 IF(XCHCK.GE.XKSI) GO TO 21
      IF(IDM.GE.LPK) SPACE = FSPACE
      XCHCK = XCHCK+SPACE
      IDM = IDM+1
```

```
      GO TO 22
C  K<SI EXISTS BTW XSI(IOM-1) AND XSI(IOM)
   21 CONTINUE
      IOMA = IOM-1
      BBTAN(ICHBY) = BETAN(IOM)+(BETAN(IOM)-BETAN(IOMA))
     X*(X<SI-XCHCK)/SPACE
C     BBTAN IS USED FOR CHEBYCHEV-GAUSS INSTEAD OF BETAN.
      GO TO 20
  488 BBTAN(ICHBY) = SBETA
C BETAN FOR ITERA.EQ.1 IS SPECIFIED IN DFSIM1.
   20 CONTINUE
  100 CONTINUE
      IF(<CTRL.EQ.4) GO TO 4
      IF (<CTRL.EQ.3) GO TO 3
      IF (<CTRL.EQ.2) GO TO 2
      IF (ISHARP.EQ.1) GO TO 10
      YINT  = 0.
      DO 110 ISJM = 1,NCHBY
      ABC = (AJ(ISJM)+A11)/(AJ(ISJM)+A12)
  110 YINT  = YINT +BBTAN(ISJM)*SQRT(ABC)
      YINT = YINT*PAI/NCHBY
      GO TO 1000
   10 CONTINUE
C  THIS IS THE CASE OF HANDLING RADED L. E. .
      NDF = 0
      XCA = 0.
      CALL DFSIM1(YINT,NDF,XCA)
C     XCA IS DUMMY, ONLY USED FOR F(5) INDEFINED.
      GO TO 1000
    2 CONTINUE
      XCA=0.
C XCA IS DUMMY.
      ISIC=2
      CALL IC2(SR,SM,XCA,ISIC)
      YINT=SR
      GO TO 1000
    3 CONTINUE
C-----INTEGRAL FOR I3.
C  AJ(N) IS CALCULATED AND STORED
      YINT = 0.
      DO 120 ISJM = 1,NCHBY
      AB1 = 1.-AJ(ISJM)
      AB2 = (AJ(ISJM)+A31)*(A32-AJ(ISJM))
      SQAB2 = SQRT(AB2)
      ABC = AB1/SQAB2
  120 YINT = YINT+ABC
      YINT = YINT*PAI/NCHBY
      GO TO 1000
C-----INTEGRAL FOR I4
C     SINCE BETA(N) BTWN TOT AND TET ARE
C     EXPECTED TO BE ALWAYS SMOOTH, USE GAUSS-
C     CHEBYSHEV QUADRATURE FORMULA.
C     AJ(N) IS ALREADY CALCULATED.
C     IF THIS IS THE FIRST CASE FOR BETAN2,
C     USE A CONSTANT FOR BETAN2.
C     BBTAN2 IS USED FOR CHEVY-GAUSS INSTEAD OF BETAN2.
    4 CONTINUE
      IF(ITERA.GE.2) GO TO 150
      IF(IJ.GE.2) GO TO 191
C  SBETA2 MUST BE READ FOR THE FIRST RUN.
```

```
      DO 180 IC4BY = 1,NC4BY
  180 BBTAN2 (IC4BY) = SBETA2
      NS21=NS2+1
      DO 185 IDD=1,NS21
  185 BETAN2(IDD)=SBETA2
      GO TO 181
  150 CONTINUE
      IF(IJ.GE.2) GO TO 181
      ID99 = 1
      XCHCK = XST(2)
      DO 170 IC4BY = 1,NC4BY
      XXSI = FCA5*AJ(IC4BY)+FC15
  152 IF(XCHCK.GE.XXSI) GO TO 151
      XCHCK = XCHCK + SPACE2
      ID99 = ID99+1
      GO TO 152
  151 CONTINUE
      IDMMA = ID99-1
      BBTAN2(IC4BY) = BETAN2(IDMM)
     1+(BETAN2(ID99)-BETAN2(IDMMA))*(XXSI-XCHCK)/SPACE2
      ILM=IC4BY
      XXSI = FCA5*AJ(ILM  )+FC15
      WRITE(6,250) ILM,BBTAN2(ILM),XXSI
  250 FORMAT(15X,*I=*,I3,2X,*BBTAN2=*,E14.7,2X,*XXSI=*,E14.7)
  170 CONTINUE
  181 CONTINUE
      YINT = 0.
      DO 190 ISJM = 1,NC4BY
      AB1 = (BBTAN2(ISJM)+PAI)*(1.+AJ(ISJM))
      AB2 = (AJ(ISJM)+A41)*(AJ(ISJM)+A42)
      SQAB2 = SQRT(AB2)
  190 YINT = YINT + AB1/SQAB2
      YINT = YINT*PAI/NC4BY
 1000 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE CAVITY (XCC,YCC)
C THIS SUBROUTINE IS CALLED FROM DXFNEW FOR F(5).
      DIMENSION CKEX(100),CKEY(100),ANSI1(100),SRI2(100),SIC3I3(100)
      DIMENSION SIC4I4(100),XST(7)
      DIMENSION CAVX(100),CAVY(100)
      COMMON YCCC,SBETA2
      COMMON XII4(200),XIIN(200),ANSS2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LP44,NS2
      COMMON AJ(100),ISHAR,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALPA1,GA444
      COMMON       SBETA,XX4,ICPI,SARCOO(513)
      COMMON IJJ,XA,XB,XC,TANS,EP,RC,YR,JBIGS,K_BIGS,BIGS,SMALS,DSS
      COMMON XSN(7),     CLC,ERC,YYY,XM,ITERA,SXSIO(7),SXSIOO(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LP4,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XCX
      COMMON XRDJND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAJS(100),VGAJS(100),VGAJS
C XCCC IS THE CAVITY END POINT CALCULATED IN SUB. CAVITY.
      CDEL = COS(DELTA)
      SDEL = SIN(DELTA)
      PAI = 3.141592654
      DO 1 LDA=1,7                                                    C
    1 XST(LDA) = YXS(LDA)
      SQR4 = SQRT(1.+XST(6))
      CCC1=ALOG(1.+XST(6))/(2.*PAI)
      NCAV=80
      NCAV1=NCAV+1
      CAVS = (XST(2)-XST(1))/NCAV
C     LEAVE THE LAST POINT OF XSI = 0 SINCE THERE IS A
C        SINGULARITY FOR SINGLE SPIRAL VORTEX MODEL.
      DO 2 KLM = 1,NCAV1
      XCA = XST(1) +CAVS* (KLM-1)
C     REAL PART OF OMEGA = BETA* PAI.
      IF (KLM.EQ.1) GO TO 3
      IF(KLM.EQ.NCAV1) GO TO 10
C-----IC1(XSI) CALCULATION, CALLING DFSIM1.
      IF (IJ.GE.34) GO TO 75
      NDF = 3
      CALL DFSIM1(ANS,NDF,XCA)
C     ANS IS A SOLUTION FOR IC1(XCI), XCI IS IDENTICAL TO XCA.
      IF (IJ.EQ.27) ANSI1(KLM) = ANS
      GO TO 76
   75 ANS = ANSI1(K_M)
   76 CONTINUE
C---- IC2(XSI) CALCULATION.
      IF(IJ.GE.34) GO TO 77
      ISIC = 1
      CALL IC2(SR,SM,XCA,ISIC)
C     ONLY SR IS UTILIZED-- SM IS FOR PRINT.
      IF (IJ.EQ.27) SRI2(KLM) = SR
      GO TO 78
   77 SR = SRI2(KLM)
   78 CONTINUE
C-----IC3 (XSI) CALCULATION-- USE CHEBYSHEV-GAUSS
C     QUADRATURE FORMULA.
      BPC3 = (XST(1)+XST(2))*.5
      CM85 = (XST(2)-XST(1))*.5
      A31 = (BPC3+1.)/CM85
      A32 = (-BPC3+XST(3))/CM85
      SK1 = XCA-XST(2)
```

```
      EK2 = (XCA+1.)*(XCA-XST(1))*(XCA-XST(3))
      EK3 = SQRT(EK1/EK2)
      EF33 = CM35*EK3
      IF (IJ.GE.34) GO TO 33
      SIC3 = 0.
      DO 5 ISJM = 1,NCHBY
      EJ1=(AJ(ISJM)+A31)*(A32-AJ(ISJM))
      SEJ1 = SQRT(EJ1)
      EF3 = (1.-AJ(ISJM))/SEJ1
      EF3A = CM35*AJ(ISJM)+EPC5-XCA
    5 SIC3 = SIC3+(EF3-EF33*SQRT(1.-AJ(ISJM)**2))/EF3A
      SIC3 = SIC3*PAI/NCHBY
      SIC3 = SIC3+ALOG((XST(2)-XCA)/(XCA-XST(1)))*EK3
      IF(IJ.EQ.27) SIC3I3(KLM) = SIC3
      GO TO 31
   30 SIC3 = SIC3I3(KLM)
   31 CONTINUE
C-----IC4(XSI)----.
C     USE CHEBYSHEV-GAUSS QUADRATURE FORMULA
C        IN THE SAME MANNER AS THAT FOR IA IN
C        OFSIM3.
      IF(IJ.GE.34) GO TO 32
      EPC5 = (XST(3)+XST(2))*.5
      EMC5 = (XST(3)-XST(2))*.5
      A41 = (EPC5+1.)/EMC5
      A42 = (EPC5-XST(1))/EMC5
      SIC4 = 0.
      DO 7 ISUM= 1,NCHBY
      RA = (BETAN2(ISJM)+PAI)*(1.+AJ(ISJM))
      RB = (AJ(ISJM)+A41)*(AJ(ISJM)+A42)
      SRB = SQRT(RB)
      RC = RA/SRB
      RD = EMC5*AJ(ISUM)+EPC5-XCA
    7 SIC4 = SIC4+RC/RD
      SIC4 = SIC4*PAI/NCHBY
      IF(IJ.EQ.27) SIC4I4(KLM)= SIC4
      GO TO 33
   32 SIC4 = SIC4I4(KLM)
   33 CONTINUE
      IF (IJ.EQ.27.AND.KLM.EQ.2) WRITE(6,35) ANS,SR,SIC3,SIC4,KLM
      IF (IJ.EQ.27.AND.KLM.EQ.40) WRITE(6,35) ANS,SR,SIC3,SIC4,KLM
      IF (IJ.EQ.27.AND.KLM.EQ.80) WRITE(6,35) ANS,SR,SIC3,SIC4,KLM
   35 FORMAT (10X,*---I1,I2,I3,I4 OF CAVITY ARE---*,4(E14.7,2X),2X,
     A*(KLM=*,I4)
C  40(XSI) = 1/EK3  ALREADY CALCULATED.
      JJ2 = COS(ALPAI+GAMMA)/COS(XST(3)+GAMMA)/XST(7)                    C
      SC = (-ANS/PAI-SR*(COS1-ALOG(JJ2)/PAI)*SIC3
     1-SIC4/PAI)/EK3
      GO TO 25
    3 SC = BETAB*PAI
      GO TO 25
   10 SC=BETAC*PAI
C BETAB AND BETAC( BODY ANGLES AT B AND C) MUST BE SPECIFIED IN COMMON.
   25 CONTINUE
      XXS = XCA*CDEL
      YYT = XCA-XST(4)*SDEL
      YYT2 = YYT**2
      XXU = XST(4)*CDEL
      XXU2 = XXJ**2
      XY3 = YYT2+XXJ2
```

```
      DJDX = DSAP*XXS/(XY3*PAI)
      CSC = COS(SC)
      SSC = SIN(SC)
      CFC = J.DX/SCSM
      C(EK(KLM) = CSC*CFC
      S(EY (KLM) = SSC*CFC
    2 CONTINUE
      CAVXX(1)=0.
      CAVYY(1)=J.
      DO 15 ICAV=3,NCAV1,2
      CAVXX(ICAV) = CAVXX(ICAV-2)+CAVS*(C(EX(ICAV-2)+4.*
     1C(EX(ICAV-1)+C(EX(ICAV))/3.
   15 CAVYY(ICAV) = CAVYY(ICAV-2)
     1+CAVS*(SKEY(ICAV-2)+4.*S(EY(ICAV-1)+SKEY(ICAV))/3.
      IF(IJ.EQ.27) GO TO 100
      GO TO 101
  100 DO 102 ICAV=1,NCAV1,2
      CAVX(ICAV)=CAVXX(ICAV)
  102 CAVY(ICAV)=CAVYY(ICAV)
      XCCC=CAVX(NCAV1)
      YCCC=CAVY(NCAV1)
  101 CONTINUE
      XCC=CAVXX(NCAV1)
      YCC=CAVYY(NCAV1)
      RETURN
      END
```

```
      SUBROUTINE G2 (XS2,AG2,IS2)
      DIMENSION    XST(7),XI21S(200),XI22S(200),XI23S(200),XI24S(200)
      COMMON YCCC,SBETA2
      COMMON XIT4(200),XITN(200),ANSG2S(200),SARG2(200)
      COMMON CA/K(100),CA//(100),BETAB,BETAC,XCCC,NCA/,LP44,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON /LAPAN,DELTA,DSAP,ALPA1,SA444
      COMMON       SBETA,XX44,ICPI,SARCOD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSV(7),      DLE,ERC,YYY,XM,ITERA,SXSIO(7),SXSIOO(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LP4,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XJK
      COMMON XROJN2,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TSAJS(100),WSAJS(100),NGAUS
C     THIS SUBROUTINE IS CALLED BY DFSI45.
C     THIS SUBROUTINE CALCULATES FUNCTION G2(XS2) WHICH
C     INCLUDES I21(XS2) TO I24(XS2).
C     XS2 IS XSI- AG2 IS THE SOLUTION OF INTEGRALS.
      DO 1 IQP=1,7                                                      C
    1 XST(IQP)=YXS(IQP)
      PAI = 3.141592654
      CCC1=ALOG(1.+XST(6))/(2.*PAI)
      IF (IJ.GE.47) GO TO 100
C---I21(XSI)----.
C     THE SAME INTEGRATION AS THAT IN
C     SUBROUTINE CAVITY FOR GC(XSI)
      NDF = 3
      CALL DFSI41(ANS,NDF,XS2)
      XI21 = ANS
      IF(IJ.EQ.40) XI21S(IS2) = XI21
C----I22(XSI)----.
C     USE THE SAME SUBROUTINE IC2 AS
C     USED IN CAVITY WITH ISIC=1.
      ISIC=1
      CALL IC2(SR,S4,XS2,ISIC)
      XI22 = SR
C     NOTE THAT S4 IS DUMMY VARIABLE.
      IF(IJ.EQ.40) XI22S(IS2) = XI22
C----I23(XSI)----.
C     USE CHEBYCHEV-GAUSS QUADRATURE FORMULA
C       IN EXACTLY SIMILAR MANNER TO THAT IN
C         DFSI43 FOR I3.
      XI23 = 0.
      BPC5 = (XST(1)+XST(2))*.5
      C485 = (XST(2)-XST(1))*.5
      A31 = (BPC5 + 1.)/C485
      A32 = (-BPC5 + XST(3))/C485
      DO 2 ISUM = 1,NCHBY
      HA1 = 1.-AJ(ISUM)
      HA2 = (AJ(ISUM) + A31)*(A32-AJ(ISUM))
      SHA2 = SQRT(HA2)
      F3I3 = HA1/SHA2
      F3AI3 = C485*AJ(ISUM)+BPC5-XS2
    2 XI23 = XI23+F3I3/F3AI3
      XI23 = XI23*PAI/NCHBY
      IF (IJ.EQ.40) XI23S(IS2) = XI23
C----I24-----.
C     USE CHEBYCHEV-GAUSS QUADRATURE
C        FORMULA BY ASSUMING THAT
C        THE KERNEL FCN. IS SMOOTH.
```

```
      HJ = (XS2+1.)*(XS2-XST(1))*(XST(3)-XS2)
      HV = XS2-XST(2)
      HW = SQRT(HJ/HV)
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      XI24 = 0.
      DO 10 ISUM = 1, NCHBY
      TPA1 = AJ(ISUM)+A41
      TPA2 = AJ(ISUM)+A42
      STP = SQRT(TPA1*TPA2)
      F4T = (BETAN2(ISJ4)+PAI)*(1.+AJ(ISJ4))/STP
C     BETAN2 IS CHEBY-GAUSS VERSION FOR BETA ON THE SECOND ARC.
      F4A = FMC5*AJ(ISJ4)+FPC5-XS2
      ST2 = SQRT(1.-AJ(ISJ4)**2)
      F4B = FMC5 *ST2*(BETAN2(IS2 )+PAI)/HW
   10 XI24 = XI24+(F4T-F4B)/F4A
      XI241 = XI24*PAI/NCHBY
C     BETAN2 IS USED FOR SIMPSONIS RULE.
      XLG = ALOG((XST(3)-XS2)/(XS2-XST(2)))
C     IS2 IS TRANSFERRED THROUGH S2-ARGUMENT.
      XI242 = XLG*(BETAN2(IS2)+PAI)/HW
      XI24 = XI241+XI242
      IF(IJ.EQ.40) XI24S(IS2) = XI24
      GO TO 101
  100 XI21 = XI21S(IS2)
      XI22 = XI22S(IS2)
      XI23 = XI23S(IS2)
      XI24 = XI24S(IS2)
  101 XS24 = -XI21/PAI-XI22
      XS23 = COS(1-ALOG(COS(4.*FA1+3A444A)/COS(XST(5)+3A444A)/XST(7)))/PAI          C
      XS2C = XS23+XI23
      XS2D = -XI24/PAI
      A32 = (XS2A+XS2C+XS2D)*HW
      IF (IJ.EQ.27.AND.IS2.EQ.2) WRITE(6,52) XI21,XI22,XI23,XI24,IS2
      IF (IJ.EQ.27.AND.IS2.EQ.10) WRITE(6,52) XI21,XI22,XI23,XI24,IS2
      IF (IJ.EQ.27.AND.IS2.EQ.30) WRITE(6,52) XI21,XI22,XI23,XI24,IS2
   52 FORMAT(10(,*----I1,I2,I3,I4 OF F(5) ARE---*,4(E14.7,2X),2X,
     A *IS2=*,I4)
      RETURN
      END
```

```
      SUBROUTINE RMINT (SR,SM,MIQ)
      DIMENSION XST(7)
      COMMON YCOO,SBETA2
      COMMON XITM(200),XITN(200),ANSQS(200),SARC2(200)
      COMMON CAMX(100),CAMY(100),BETAB,BETAC,XCOO,NCAM,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALPHA1,GAMMA
      COMMON       SBETA,KKM,ICPI,SARCOO(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSV(7),      CLE,ERC,YYY,XM,ITERA,SXSID(7),SXSIDD(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XRJJNO,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,T3AUS(100),WGAUS(100),NGAUS
      PAI = 3.141592654
      IF (ICPI.EQ.0) GO TO 10
      DO 12 IS = 1,7                                                    C
   12 XST(IS) = XSV(IS)
      GO TO 11
   10 DO 1 IS = 1,7                                                     C
    1 XST(IS) = YXS(IS)
   11 CONTINUE
      XX1 = XST(4)*SIN(DE_TA)
      YY1 = XST(4)*COS(DE_TA)
      YY12 = YY1**2
      CB5 = (XST(2)-XST(1))*.5
      BC5 = (XST(1)+XST(2))*.5
      A31 = (BC5+1.)/CB5
      A32 = (-BC5+XST(3))/CB5
      BM15 = (XST(1)-1.)*.5
      BP15 = (XST(1)+1.)*.5
      A11 = (BM15-XST(2))/BP15
      A12 = (BM15-XST(3))/BP15
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      IF(MIQ.EQ.4) GO TO 4
      IF (MIQ.EQ.3) GO TO 3
      IF (MIQ.EQ.2) GO TO 2
C     AJ(I) ARE ALREADY CALCULATED IN SUBROUTINE
C          TRINT_T AND STORED IN COMMON AREA.
      SR=0.
      SM=0.
      DO 20 ISUM = 1,NCHBY
      GX1 = 1.-AJ(ISUM)
      GY1 = (AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SGY1 = SQRT(GY1)
      FF3 = GX1/SGY1
      FX1 = CB5*AJ(ISUM)+BC5
      FX2 = FX1-XX1
      FX22=FX2**2
      FX3 = FX22+YY12
      FF31 = FX2/FX3
      FF32 = YY1/FX3
      SR = SR+FF3*FF31
   20 SM = SM+FF3*FF32
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
```

```
    2 CONTINUE
      IF (ISHARP.EQ.1) GO TO 100
C     ISHARP = 1 MEANS THAT THE FOIL HAS ROUNDED L.E.
C     SO THAT THE SIMPSON'S RULE IS USED.
C     ISHARP = 0 MEANS THAT THE FOIL HAS SHARP L.E.
C     SO THAT CHEBYSHEV GAUSS FORMULA CAN BE USED AS BELOW.
      SR = 0
      SM = 0
      DO 30 ISUM = 1,NCHBY
      ST11 = AJ(ISUM)+A11
      ST12 = AJ(ISUM)+A12
      FK1 = BETAN(ISUM)*SQRT(ST11/ST12)
      UN1 = BP15*AJ(ISUM)+BM15-XX1
      UN12 = UN1**2
      UN13 = UN12+YY12
      FK11 = UN1/UN13
      FK12 = YY1/UN13
      SR = SR+FK1*FK11
   30 SM = SM+FK1*FK12
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
  100 CONTINUE
C     THIS IS THE CASE THAT THE FOIL HAS ROUNDED L.E.
      NDF = 1
      XCA = 0.
      CALL DFSIM1(SR,NDF,XCA)
C  (CA IS DUMMY----ONLY USED FOR F(5) IN DXFNEW.
      NDF=2
      CALL DFSIM1(SM,NDF,XCA)
      GO TO 1000
    3 CONTINUE
C     USE CHEBYSHEV-GAUSS FORMULA SINCE BETA
C     IN THIS REGION IS SMOOTH.
C     BETAN2 (ISUM) ARE ALREADY CALCULATED AT TPINT.
      SR = 0.
      SM = 0.
      DO 50 ISUM = 1,NCHBY
      PSL = (BETAN2(ISUM)+PAI)*(1.+AJ(ISUM))
      PSM = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
      SQPSM = SQRT(PSM)
      FF4 = PSL/SQPSM
      PSN = FMC5*AJ(ISUM)+FPCE-XX1
      PSN2 = PSN**2
      FF41 = PSN/(PSN2+YY12)
      FF42 = YY1/(PSN2+YY12)
      SR = SR+FF4*FF41
      SM =SM+FF4*FF42
   50 CONTINUE
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
    4 CONTINUE
C     XCA IS DUMMY. ONLY USED FOR AC2 IN F(5)
      XCA = 0.
      ISIC = 0
C     SUBROUTINE IC2 IS ALSO USED IN F(5).
      CALL IC2(SR,SM,XCA,ISIC)
 1000 RETURN
      END
```

```
      SUBROUTINE SHAPE(X,Y,BETA,IS1I2)
      COMMON/FREECAV/XFREEC,YFREEC
      COMMON/UPPER/A2AAJ,B23BJ,C2CCJ,AAAAJ,B6BBJ,CCCCJ,A8J,B8J,C8J,D8J
      COMMON YCCC,SBETA2
      COMMON XITN(200),XITV(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHAR,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFAI,SAMM
      COMMON       SBETA,XKM,ICPI,SARCOD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(7),     CLE,ERC,YYY,XM,ITERA,SXSIG(7),SXSIOO(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B23B,C2CC
      COMMON AAAA,B3BB,CCCC,AB,BB,CB,DB,TBAJS(100),WGAUS(100),NGAUS
      PAI =3.141592653
      X2=X**2
      X3=X**3
      XS=SQRT(X)
      X4=X*XS
      XFREE2=XFREEC**2
      XFREE3=XFREEC**3
      XFREES=SQRT(XFREEC)
      XFREE4=XFREEC*XFREES
      X22=.2**2
      X23=.2**3
      X2S=SQRT(.2)
      X2M=.2*X2S
      X82=.8**2
      X83=.8**3
      X8S=SQRT(.8)
      X8M=X8S*.8

C  WE MUST CHECK TO SEE IF WE ARE GOING TO CALCUATE THE TOP PART
C  OR THE BOTTOM PART.  IF TOP WE TRANSFER TO 2ND HALF OF ROUTINE.
C  IS1I2 = 3 IS USED FOR CALCULATIONS OF UPPER FOIL PROFILE

      IF(IS1I2.EQ.1) GO TO 30
      IF (IS1I2.EQ.3) GO TO 80

      IF (X.LE..2) GO TO 15
      IF (X.LE..8) GO TO 20
      IF (X.GT..8) GO TO 25

   15 Y=A2AA*X+B23B*X2+C2CC*X3
      YDX=A2AA+B23B*2.*X+C2CC*3.*X2
      BETA=ATAN(YDX)
      GO TO 50
   20 Y=AAAA*(4./3.*X+8./3.*X4-4.*X2)+B3B3*X+CCCC*XS
      YDX=AAAA*(8./3.+8./3.*1.5*XS-8.*X)+B3B3+.5*CCCC/XS
      BETA=ATAN(YDX)
      GO TO 50
   25 Y=A8+B8*X+C8*X2+D8*X3
      YDX=B8+2.*C8*X+3.*D8*X2
      BETA=ATAN(YDX)
      GO TO 50

C THIS 2ND HALF  OF THE ROUTINE IS FOR CALCULATING THE UPPER HALF

   30 IF (IS1I2.EQ.3) GO TO 70
```

```
      IF (XFREEC.LE.2) GO TO 35
      IF (XFREEC.LE.8) GO TO 50
      IF (XFREEC.GT.8) GO TO 55
   70 CONTINUE
      IF (X.LE.2) GO TO 35
      IF (X.LE.8) GO TO 50
      IF (X.GT.8) GO TO 55

   55 IF (IS112.EQ.3) GO TO 80
      R1=YFREEC-A2AAU*XFREEC-B2B2U*XFREE2-C2CCU*XFREE3
      GO TO 81
   80 R1=0.
   81 CONTINUE
      IF (X.GT.2) GO TO 40
      Y=A2AAU*X+B2B8U*X2+C2CCU*X3+R1
      YDX=A2AAU+2.*B2B8U*X+3.*C2CCU*X2
      BETA=ATAN(YDX)-PAI
      GO TO 60
   40 Y2=A2AAU*.2+B2B8U*X22+C2CCU*X23+R1
      R2=Y2-AAAAU*(4./3.*.2+8./3.*X24-4.*X22)-8888U*.2-CCCCU*X2S
      IF (IS112.EQ.3) R2=0.
      IF(X.GT.8) GO TO 45
      Y=AAAAU*(4./3.*X+8./3.*X4-4.*X2)+8888U*X+CCCCU*XS+R2
      YDX=AAAAU*(4./3.+8./3.*1.5*XS-6.*X)+8888U+.5+CCCCU/XS
      BETA=ATAN(YDX)-PAI
      GO TO 60
   45 Y3=A8U+B8U*.8+C8U*X82+D8U*X83+R2
      R3=Y3-A8U-B8U*.8-C8U*X82-D8U*X83
      IF (IS112.EQ.3) R3=0.
   46 Y=A8U+B8U*(+C8U*X2+D8U*X3+R3
      YDX=B8U+2.*C8U*X+3.*D8U*X2
      BETA =ATAN(YDX)-PAI
      GO TO 60
   50 IF (IS112.EQ.3) GO TO 90
      R2=YFREEC-AAAAU*(4./3.*XFREEC+8./3.*XFREE4-4.*XFREES)-8888U*XFREEC
     1 -CCCCU*XFREES
      GO TO 91
   90 R2=0.
   91 CONTINUE
      IF (X.GT.8) GO TO 45
      Y=AAAAU*(4./3.*X+8./3.*X4-4.*X2)+8888U*X+CCCCU*XS+R2
      YDX=AAAAU*(4./3.+8./3.*1.5*XS-8.*()+8888U+.5+CCCCU/XS
      BETA=ATAN(YDX)-PAI
      GO TO 60
   55 IF (IS112.EQ.3) GO TO 100
      R3=YFREEC-A8U-B8U*XFREEC-C8U*XFREE2-D8U*XFREE3
      GO TO 101
  100 R3=0.
  101 CONTINUE
      GO TO 46

   60 RETURN
      END
```

```
      SUBROUTINE XCYC(XCB,YCB,CX,CY)
      COMMON/UPPER/A2AAU,B2BBU,C2CCU,AAAAJ,BBBBJ,CCCCJ,A8J,B8J,C8U,D8U
      XX=CX
      X2=XX**2
      X3=XX**3
      XXS=SQRT(XX)
      X5=XX*XXS
      IP=0
      IF (CX.LE..2) GO TO 3
      IF (CX.LE..8) GO TO 4
      IF (CX.GT..8) GO TO 5
    3 F1=A2AAJ*XX+B2BBJ*X2+C2CCJ*X3
      F2=A2AAU+2.*B2BBU*XX+3.*C2CCU*X2
      F3=XX-CX
      FXX=F1+(F3/F2-CY)
      D1=F2
      D2=(D1+F3*(2.*B2BBJ+6.*C2CCJ*XX))/D1**2
      DFXX=D1+D2
      DIV=FXX/DFXX
      XX=XX-DIV
      IP=IP+1
      Z=ABS(DIV/XX)
      IF((Z.LE..000001).OR.(IP.EQ.20)) GO TO 6
      GO TO 3
    4 F1=AAAAU*(4./3.*XX+5./3.*XX-4.*X2)+BBBBU*XX+CCCCU*XX5
      F2=AAAAU*(4./3.+8./3.*1.5*XX-8.*XX)+BBBBJ+CCCCJ*.5/XX5
      F3=XX-CX
      FXX=F1+(F3/F2-CY)
      D1=F2
      D2=(D1-F3*(AAAAJ*(8./3.*1.5*.5/XX5-5.)-CCCCJ*.5*.5/XXX))/D1**2
      DFXX=D1+D2
      DIV=FXX/DFXX
      IP=IP+1
      Z=ABS(DIV/XX)
      IF((Z.LE..000001).OR.(IP.EQ.20)) GO TO 6
      GO TO 4
    5 F1=A8J+B8J*XX+C8U*X2+D8U*X3
      F2=B8J+2.*C8U*XX+3.*D8J*X2
      F3=XX-CX
      FXX=F1+(F3/F2-CY)
      D1=F2
      D2=(D1-F3*(2.*C8U+6.*D8U*XX))/D1**2
      DFXX=D1+D2
      DIV=FXX/DFXX
      XX=XX-DIV
      IP=IP+1
      Z=ABS(DIV/XX)
      IF((Z.LE..000001).OR.(IP.EQ.20)) GO TO 6
      GO TO 5
    6 XCB=XX
      IF (CX.LE..2) YCB=A2AAU*XX+B2BBJ*X2+C2CCU*X3
      IF(CX.LE..8) YCB=AAAAJ*(4./3.*XX+5./3.*XXX-4.*X2)+BBBBJ*XX
     X +CCCCU*X5
      IF (CX.GT..8) YCB=A8J+B8J*XX+C8J*X2+D8U*X3
      RETURN
      END
```

,,

```
      SUBROUTINE ARCS2(S2,XC,YC)
      COMMON/FOIL_END/XXDD,YYDD
      COMMON/UPPER/A2AAU,B2BBU,C2CCJ,AAAAJ,BBBBU,CCCCJ,A8U,B8U,C8U,D8U
C  XXDD IS THE ENDPOINT OF THE UPPER FOIL OFFSET
      CXDD=XXDD
      XHIGH=0.
      XLOW=0.
      XINCRT=(CXDD-XC)/50.
      IF (XINCRT.LE.0.) XINCRT=-XINCRT
      IS1I2=1
      S2=0.
      DO 24 IINC=1,50
      XLOW=XHIGH
      XHIGH=XLOW+XINCRT
      CALL ARCLEN(S,XLOW,XHIGH,IS1I2)
   24 S2=S2+S
      RETURN
      END

"
```

```
      SUBROUTINE ARCLEN(XSS,XL,XH,IS1I2)
      COMMON YCCC,SBETA2
      COMMON XITA(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHAR*,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DBAP,ALPA1,GAMMA
      COMMON        SBETA,XX4,ICPI,SARCCC(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(7),      CLE,ERC,YYY,XM,IIERA,SXSIC(7),SXSIDC(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XRDJND,A2AA,B23B,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      DIMENSION T(100),W(100),F(100)
      N=NGAUS
      DO 5 J=1,N
      T(J)=TGAUS(J)
    5 W(J)=WGAUS(J)
    1 SUM=0.
      DO 2 J=1,N
      CALL FC2(T(J),F(J),XL,XH,IS1I2)
    2 SUM=SUM+W(J)*F(J)
      XSS=SUM
      RETURN
      END
```

"

```
      SUBROUTINE FC2(T,F,XL,XH,IS1I2)
      COMMON/UPPER/A2AAU,B2BBU,C2CCU,AAAAJ,BBBBJ,CCCCJ,A8J,B8J,C8U,D8J
      COMMON YCCC,SBETA2
      COMMON XLIM(200),XIIM(200),ANSS2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AU(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALPA1,GAMMA
      COMMON        SBETA,XXH,ICPI,SARCD(513)
      COMMON IOJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(7),      CLE,ERC,YYY,XM,ITERA,SXSIO(7),SXSIOD(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IU,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      IICONT=1
      XP=(XH-XL)*T+.5*(XH+XL)+.5
      SXP=SQRT(XP)
      X2=X**2
      IF(XP.GE..8) GO TO 1
      IF(XP.LE..2.AND.IICONT.EQ.1) GO TO 4
      IF(XP.LE..2)  GO TO 3
      P1=(4./3.+4.*SX-4.*X)*AAAA
      P2=BBBB
      P3=.5*CCCC/SX
      IF (IS1I2.EQ.1) P1=(4./3.+4.*SX-4.*X)*AAAAU
      IF (IS1I2.EQ.1) P2=BBBBU
      IF (IS1I2.EQ.1) P3=.5*CCCCU/SX
      GO TO 2
    3 P1=-.5*SQRT(2.*XROUND)/SXP+A2AA
      P2=B2BB*SX*1.5
      P3=2.*C2CC*XP
      IF (IS1I2.EQ.1) P1=-.5*SQRT(2.*XROUND)/SX+A2AAU
      IF (IS1I2.EQ.1) P2=B2BBU*SX*1.5
      IF (IS1I2.EQ.1) P3=2.*C2CCU*X
      GO TO 2
    4 CONTINUE
      P1=A2AA
      P2=2.*B2BB*XP
      P3=3.*C2CC*X2
      IF (IS1I2.EQ.1) P1=A2AAU
      IF (IS1I2.EQ.1) P2=2.*B2BBU*X
      IF (IS1I2.EQ.1) P3=3.*C2CCU*X2
      GO TO 2
    1 P1=A8
      P2=2.*C8*XP
      P3=3.*D8*X2
      IF (IS1I2.EQ.1) P1=A8J
      IF (IS1I2.EQ.1) P2=2.*C8J*X
      IF (IS1I2.EQ.1) P3=3.*D8U*X2
    2 P4=P1+P2+P3
      P42=P4**2
      P5=1.+P42
      SP5=SQRT(P5)
      F=(XH-XL)*SP5+.5
      RETURN
      END
```

```
      SUBROUTINE MOSES(A,B,ER1,ER2,X,J,XLPA,IS1I2)
      J=0
      X1=A
      X2=B
    4 J=J+1
      IF(J.GE.900) GO TO 8
      CALL FARC(PFX1,XLPA,1,IS1I2)
      CALL FARC(PFX2,XLPA,2,IS1I2)
      X3=X1+(X2-X1)*PFX1/(PFX1-PFX2)
      CALL FARC(PFX3,XLPA,X3,IS1I2)
      IF(PFX3)1,2,3
    1 X2=X3
      X1=X1
      IF(A-B)10,10,11
   10 Y=X3-ER1
      IF(Y.LE.0.) Y=0.
      GO TO 12
   11 Y=X3+ER1
   12 CALL FARC(PFY,XLPA,Y,IS1I2)
      IF(PFY) 5,2,2
    3 X1=X3
      X2=X2
      IF(A-B) 20,20,21
   20 Z=X3+ER1
      GO TO 22
   21 Z=X3-ER1
   22 CALL FARC(PFZ,XLPA,Z,IS1I2)
      IF(PFZ)2,2,5
    5 GO TO 4
    2 PP= ABS(PFX3)
      IF(PP-ER2) 6,6,4
    6 X=X3
      GO TO 7
    8 WRITE(6,9) J
    9 FORMAT(1X,24HJ=,I3)
      STOP
    7 RETURN
      END
```

```
      FUNCTION AITKEN(XX,YY,X,N)
      DIMENSION XX(1),YY(1),ZZ(21)
      IF (N)1,1,2
    1 AITKEN=YY(1)
      RETURN
    2 IF (N.GT.20) N=20
      M=N+1
      DO 3 K=1,M
    3 ZZ(K)=YY(K)
      DO 4 I=1,N
      DO 4 J=I,N
    4 ZZ(J+1)=ZZ(I)+(X-XX(I))*(ZZ(J+1)-ZZ(I))/(XX(J+1)-XX(I))
      AITKEN=ZZ(N+1)
      RETURN
      END
```

```
      SUBROUTINE DETERM (A,N,D)
C   DETERM  REVISED 02-28-73
      REAL M
      DIMENSION A(50,50),SAVEA(50,50)
      IF (N .EQ. 1)GO TO 46
      C = 1.
      NN = N
      DO 9 J = 1,NN
      DO 9 I = 1,NN
    9 SAVEA(I,J) = A(I,J)
      K = 1
      GO TO 13
   12 K = K + 1
   13 I = K + 1
      L = K
      GO TO 17
   16 I = I + 1
   17 IF (ABS(SAVEA(I,K)) .GT. ABS(SAVEA(L,K))) L = I
      IF (I .NE. NN)GO TO 16
      IF (L .EQ. K)GO TO 28
      J = K
C     DO INTERCHANGE
      GO TO 23
   22 J = J + 1
   23 SAVEK = SAVEA(K,J)
      SAVEA(K,J) = SAVEA(L,J)
      SAVEA(L,J) = SAVEK
      IF (J .NE. NN)GO TO 22
      C = -C
   28 I = K + 1
      GO TO 31
   30 I = I + 1
   31 CONTINUE
      IF (SAVEA(K,K) .EQ. 0.) GO TO 48                                  02-20-73
      M = SAVEA(I,K) / SAVEA(K,K)
      SAVEA(I,K) = 0.
      J = K + 1
      GO TO 36
   35 J = J + 1
   36 SAVEA(I,J) = SAVEA(I,J) - M * SAVEA(K,J)
      IF (J .NE. NN)GO TO 35
      IF (I .NE. NN)GO TO 30
      IF (K .NE. (NN-1))GO TO 12
      D = 1.
      DO 45 I = 1,NN
      J = I
      D = D * SAVEA(I,J)
      IF (ABS(D) .LT. 1.E-36) GO TO 46
   45 CONTINUE
      D = D * C
      RETURN
   46 D = A(1,1)
      RETURN
   48 D = 0.
      WRITE (6,51)
   51 FORMAT(///5X,'ERROR MESSAGE FROM DETERM.'/
     1 5X,'MATRIX IS SINGULAR. DETERMINANT SET = 0.' ///)
      RETURN
      END
```

```
      SUBROUTINE BBBETA(XX,RBETA,IS1I2)
C THIS GIVES BETA(X(XSI)).
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANS32S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,ISAP,ALFAI,GAMMA
      COMMON       SBETA,KKM,ICPI,SARCOO(513)
      COMMON IDJL,XA,XB,KC,TANG,EP,YC,YR,JSIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(7),     CLE,ERC,YYY,KM,ITERA,SXSIO(7),SXSIO(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LP(,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      ER1=5.E-3
      ER2=5.E-3
      IF(IS1I2.EQ.1) GO TO 20
C IS1I2=0 FOR S1.
C       1 FOR S2.
      LPMAA=LPM-1
      SMALS=SARC(LP)
      IF(LP.EQ.LPM) GO TO 10
      DSS=SARC(LP)-SARC(LP+1)
      XLPA=XX
      GO TO 21
   20 SMALS=SARC2(LP)
      IF(LP.EQ.1)GO TO 110
      XLPA=XX
      DSS=SARC2(LP)-SARC2(LP-1)
   21 CONTINUE
      X1A=XLPA
    4 X1B=X1A+.001
      CALL FARC(FAR,XLPA,(1B,IS1I2)
      IF(FAR.LT.0.) GO TO 3
      X1A=X1B
      GO TO 4
    3 CALL MOSEC(X1A,X1B,ER1,ER2,(X,JII,XLPA,IS1I2)
      GO TO 11
   10 XX=0.
      GO TO 11
  110 XX=XCCC
   11 CALL SHAPE((XX,Y,RBETA,IS1I2)
      RETURN
      END


**
```

```
      SUBROUTINE FARC(FAR,XLPA,X13,IS112)
      COMMON YCCC,SBETA2
      COMMON XITN(200),XITN(200),ANSG2S(210),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPNN,NS2
      COMMON AJ(100),ISHAR2,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFA1,GAMMA
      COMMON       SBETA,XAA,ICPI,SARCDD(513)
      COMMON IOJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(7),     CLE,ERC,YYY,XM,ITERA,SXSIG(7),SXSIGG(7),YXS(7)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XRDJND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,NGAUS(100),WGAUS(100),NGAUS
      IF(XLPA.EQ.X13) GO TO 1
      CALL ARCLEN(XSS,XLPA,X13,IS112)
      GO TO 2
    1 XSS=0.
    2 CONTINUE
      FAR=DSS-XSS
      RETURN
      END
**
```

7.0 LISTING OF PCASLDW

```
      PROGRAM PCASLDW(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE7,TAPE1)
C
C
C  NONLINEAR PARTIALLY CAVITATING CASCADE CALCULATIONS.
C  5/17/1978 PROGRAMMED BY O. FURUYA.
C----PROGRAM REVISED  FOR FIXED CAVITY LENGTH VERSION ON 9/15/78.
C          OPEN WAKE MODEL    (8/16/1979)
C
C THIS MODEL USES TWO STAGE WAKE (10/3/1979)
C
      DIMENSION YBE(6),XZ(6),BETAND(513),BETAMO(513),BETAD2(100)
      DIMENSION SXSI(6),XXX(513),CP(513)
      DIMENSION FL(200),FD(200),CP2(101),XXX2(201),FL2(100),FD2(100)
      COMMON/FOILEND/XXDD,YYDD
      COMMON/UPPER/A2AAU,B2BBU,C2CCU,AAAAJ,BBBBU,CCCCJ,AAU,BBU,CCU,DDU
      COMMON /CVTYL/CAVLEN,EIGS2
      COMMON/FREECAV/XFREEC,YFREEC
      COMMON/DE_TAD/DELT(5,6)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),AMSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NSC
      COMMON AJ(100),ISHAPP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFA1,GAMMA
      COMMON        SBETA,XXM,ICPI,SARCOD(513)
      COMMON ICJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),     CLE,ERC,YYY,AM,ITERA,SXSIO(6),SXSICC(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,YII(201),XJJ(201),XCX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AC,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      COMMON/SPC/ESPACE
      COMMON/TAJ1/JTAJ
C BETAN-----FOR ARC 1  FOR REGULAR INTEGRAL.
C BBTAN IS FOR INTERPOLATED VERSION OF BETAN .
C BETAN2 FOR EQUALLY SPACED INCREMENT FOR ARC 2.
C BBTAN2 FOR CHEBYCHEV- GAUSS VERSION OF BETAN2.
      PAI=3.141592653
      READ(5,788) JTAJ
C IF JTAJ=0   LINEAR COMB. OF VEL. FOR THAT OF  FIRST WAKE.
C    JTAJ=1   LINEAR COMB. OF PRESSURE FOR THAT  OF FIRST WAKE.
      READ(5,788) NGAUS
      NGAUS1=NGAUS+1
      NNN2=NGAUS/2
      NGAUS2=NNN2+1
      READ(5,560) (TGAUS(I),I=NGAUS2,NGAUS)
      READ(5,560) (WGAUS(I),I=NGAUS2,NGAUS)
      DO 26 IG=1,NNN2
      TGAUS(IG)=-TGAUS(NGAUS1-IG)
   26 WGAUS(IG)=WGAUS(NGAUS1-IG)
      WRITE(6,561) (TGAUS(I),I=NGAUS2,NGAUS)
      WRITE(6,562) (WGAUS(I),I=NGAUS2,NGAUS)
  560 FORMAT(4F20.10)
  561 FORMAT(1X,'T(I)=',10(F10.6,1X))
      READ (5,590) XXM

      DO 589 IDELTA=1,6
  589 READ (5,591) (DELT(IDELTA,I),I=1,5)
  562 FORMAT(1X,'A(I)=',10 (F10.6,1X))
```

```
C                                                        DDYY,DDXX,HT )(55,5(DAEP
      READ(5,560) R,AAAA,BBBB,CCCC
      READ(5,560) A8,B8,C8,D8
      READ(5,560) XROUND,A2AA,B2BB,C2CC
      READ(5,560) AAAAU,BBBBU,CCCCU
      READ (5,560) A8U,B8U,C8U,D8U
      READ (5,560) A2AAU,B2BBU,C2CCU
      READ(5,795)          NCHBY
      READ(5,1321) SBETA ,SBETA2,SF4,BETAB,BETAC
      READ(5,551) LPMS,LPKS,LPM2,IFLAG,IREAD,ISHARP
      READ(5,201) NITTR,MSTOP,MAXIT,NHK
      READ(5,202) AL  1S,GAMMAS,SCLIS,    CAVLEN
      READ(5,229) DE,DG,DF
C CAVLEN IS A CAVITY LENGTH SPECIFIED.
      DO 592 IDELTA=1,3
  592 WRITE (6,591) (DELT(IDELTA,I),I=1,6)


      WRITE(6,6553)
 6553 FORMAT(1H1)
      READ(5,6666) ESPACE
 6666 FORMAT(F10.5)
      WRITE(6,6667) ESPACE
 6667 FORMAT(1X,///,1X,*ESPACE=*,F5.2,///)
      WRITE(6,5551) BETAB,BETAC
      WRITE(6,565) R,AAAA,BBBB,CCCC
      WRITE(6,566) A8,B8,C8,D8
      WRITE(6,567) XROUND,A2AA,B2BB,C2CC
      WRITE (6,523) AAAAU,BBBBU,CCCCU
      WRITE(6,524) A8U,B8U,C8U,D8U
      WRITE(6,525) A2AAU,B2BBU,C2CCU
      WRITE(6,1229) LPMS,LPKS,SBETA,IREAD,NCHBY
      WRITE(6,1324) DE,DG,DF,SF4
      WRITE(6,1521) SBETA2
  523 FORMAT(20X,*AAAAU=*,F10.6,2X,*BBBBU=*,F10.6,2X,*CCCCU=*,F10.6)
  524 FORMAT(20X,*A8U=*,F10.6,2X,*B8U=*,F10.6,2X,*C8U=*,F10.6,2X,*D8U=*,
     1 F10.6)
  525 FORMAT(20X,*A2AAU=*,F10.6,2X,*B2BBU=*,F10.6,2X*C2CCU=*,F10.6)
  590 FORMAT (8F10.6)
  591 FORMAT (10X,*DELTA(I,J)=*,7(F10.5,2X))
  565 FORMAT(20X,*R=*,F5.2,2X,*AAAA=*,F10.6,2X,*BBBB=*,F10.6,2X,*CCCC=*,
     XF10.6)
  566 FORMAT(20X,*A8=*,F10.6,2X,*B8=*,F10.6,2X,*C8=*,F10.6,2X,*D8=*,F10.
     X6)
  567 FORMAT(20X,*XROUND=*,F10.6,2X,*A2AA=*,F10.6,2X,*B2BB=*,F10.6,2X,*C
     X2CC=*,F10.6)
  795 FORMAT(8I10)
C AAAA,BBBB,CCCCARE CONSTANTS FOR 2-TERM CAMBER, X AND SQRT(X)
C  ---------CALCULATED FROMANOTHER PROGRAM CALLED *CAMBER*----------.
C A8,B8,C8 AND D8 ARE COEFFICIENTS FOR POLYNOMIALS FOR X GREATER THAN .6.
C CLDD AND CLDDK ARE NO. DUMMY.
C SF4 IS USED FOR DETERMINING WHETHER TO CALCULATE BETA.
 1321 FORMAT(5E14.7)
C IFLAG=1 NEEDS DATA CARDS FOR SXSI(I). I=1,5, IREAD MAY BE SET TO 5.
C IF IFLAG=0 , DATA WILL BE READ EITHER FROM
C         DATA CARD, IF IREAD=5
C         TAPE1     , IF IREAD=1.
  551 FORMAT(10I5)
  201 FORMAT(4I8)
```

```
  202 FORMAT(4E14.7)
C DE,DG,DF ARE THE INCREMENTS FOR DERIVATIVES IN CXFNE..
C DG=1.E-3 & DF=1.E-5 ARE USED BEFORE.
  229 FORMAT(3E14.7)
 1229 FORMAT(5X,4HLPM=,I4,2X,4HLPK=,I4,2X,6HSBETA=,E14.7,5X,6HIREAD=,I1,
     X2X,*NOMBY=*,I3)
 5651 FORMAT(20X,*BETAB AND BETAC AS FIRST GUESS=*,F10.5,2X,F10.5)
 1324 FORMAT(10X,3HDE=,E14.7,2X,3HDG=,E14.7,3HDF=,E14.7,2X,4HSF4=,E14.7)
 1521 FORMAT(10X,*SBETA2=*,E14.7)
      SBETA2=SBETA2*PAI/180.
      BETAB=BETAB*PAI/180.
      BETAC=BETAC*PAI/180.
C  LPMM=LPM2=NS2
      LPMM=LPM2
      NS2=LPM2
      LPMM1=LPMM+1
      WRITE(6,1489) LPM2,ISHARP
 1489 FORMAT(10X,*LPM2=*,I3,2X,*ISHARP=*,E14.7)
C ISHARP=0 FOR SHARP L.E.
C        1 FOR ROUNDED L.E.
      SBETA=SBETA*PAI/180.
      DO 999 IJKL=1,NITER
C FFF4 IS PROVIDED FROM CXFNE.. BUT IF THE LOOP DOES NOT GO THROUTH
C     IT, FFF4 OF PRESET VALUE MUST BE USED.
      FFF4=0.
      ALFA1D=ALFA1S
      GAMMAD=GAMMAS
      SOLID=SOLIS
      IF(NMK.EQ.1) GO TO 240
      IF(NMK.EQ.2) GO TO 241
      SOLID=SOLIS+0.1*FLOAT(IJKL-1)
      GO TO 243
  241 GAMMAD=GAMMAS+2.*FLOAT(IJKL-1)
      GO TO 243
  240 ALFA1D=ALFA1S-2.*FLOAT(IJKL-1)
  243 CONTINUE
      XM=XXM
      ALFA1=ALFA1D*PAI/180.
      DSAP=1./SOLID
      GAMMA=GAMMAD*PAI/180.
      DELTA=ALFA1+GAMMA
      FLAPAN=0.
      WRITE(6,666) ALFAID,GAMMAD,SOLID
  666 FORMAT(1X,16HINCIDENCE ANGLE=,E14.7,1X,6HGAMMA=,E14.7,1X,9HSOLIDIT
     XY=,E14.7)
      WRITE(6,663) FLAPAN
  663 FORMAT(5X,11HFLAP ANGLE=,E14.7)
      STOLL=2.E-4
      STOLS=5.E-4
      ERC=1.E-2
      CLE=1.E-4
      WRITE(6,511) CAVLEN
  511 FORMAT(10X,*CAVITY LENGTH=*,E14.7)
C SPECIFY HYDROFOILTS CHARACTERISTICS AND SEP. POINTS.
      XC=0.
      YC=0.
      XB=0.
      XA=1.
      XXOD=1.00000
      YYOD=A5U+B5U+C5U+D8J
```

```
      WRITE(6,502)XA,XB,XC,YC,XXOO,YYOO
  502 FORMAT(10X,6HCHORD=,E14.7,2X,17HUPPER SEP. POINT=,E14.7,2X,20HCONN
     X, POINT(XC,YC)=(,E14.7,1H,,E14.7,1H)/*  XXOO=*,F10.6,2X,*YYOO=*,
     Y F10.6)
C START ITERATIVE PROCEDURE.
C      -----BASIC FLOW IS THAT OF FLAT PLATE-----.
C ITERAT IS INDEX FOR NUMBER OF ITERATIONS.
      ITERA=1
      IF(IFLAG.EQ.0) ITERA=2
      BIGS=0.
      XHIGH=0.
      XLOW=0.
      IS1I2=0
      XINCRT=XA/50.
      DO 248 IINC=1,50
      XLOW=XHIGH
      XHIGH=XLOW+XINCRT
      CALL ARCLEN(S,XLOW,XHIGH,IS1I2)
  248 BIGS=BIGS+S
C ----FIND BIGS2-----
C         FIRST CALL SHAPE TO FIND A CORRESPONDING TO CAVLEN.
      XCCC=CAVLEN
      XFREEC=CAVLEN
      CALL SHAPE(CAVLEN,Y,BETA,3)
      WRITE(6,2000) Y
 2000 FORMAT(5X,*Y=*E14.7)
      YFREEC=Y
      YCCC =Y
      CALL ARCS2(BIGS2,CAVLEN,Y)
      WRITE(6,504) BIGS,BIGS2
  504 FORMAT(10X,5HBIGS=,E14.7,5X,*BIGS2=*,E14.7)
C CALCULATION OF THE BLADE TRAILING EDGE THICKNESS.
      CALL SHAPE(1.0,UPEND,BETA,3)
      CALL SHAPE(1.0,DNEND,BETA,0)
      THBL=UPEND-DNEND
      WRITE(6,2001) UPEND,DNEND,THBL
 2001 FORMAT(10X,*UPEND AT X=1 ------*,F6.4,3X,*DNEND AT X=1 ------*,
     X  F6.4,3X,*BLADE THICKNESS AT X=1 ------*,F6.4)
      STOL=1.E-5
      LPM=LPMS
      LPK=LPKS
      LPM1=LPM-1
      LPM3=LPM-3
C ICPI IS USED FOR CONTROLLING PROGRAM; 0 FOR ITER. 1 FOR THE REST.
C FIND XSIB,XSIC,XSIF,A,ALF2 BY USING NEWTON,S METHOD.
C SXSI(1)=XSIB
C SXSI(2)=XSIC
C SXSI(3)=XSIF
C SXSI(4)=A WHICH IS THE COEFFT. OF MAPPING FCN.
C SXSI(5)=ALF2
C SXSI(6)=SIGMA
C SXSI(7)=XSIG (LOWER FIRST WAKE CLOSUER POINT)
C SXSI(8)=XSIH (UPPER FIRST WAKE CLOSUER POINT)
      IF(IJKL.GE.2) GO TO 630
      IF(IFLAG.EQ.0) GO TO 779
C INATIAL GUESS FOR SXSI(I) IS ----------
      READ(5,768) (SXSI(KX),KX=1,8)
      GO TO 160
  779 READ(IREAD,620) (SXSI(KX),KX=1,8)
  620 FORMAT(8F10.7)
```

```
  629 DO 621 IC=1,LPM
  621 READ(IREAD,622) SARC(IC),BETAN(IC)
  622 FORMAT(2E14.7)
      DO 1621 IC=1,LPMM1
 1621 READ(IREAD,622) SARC2(IC),BETAN2(IC)
      IF(IFLAG.EQ.0) GO TO 480
      GO TO 481
  480 DO 482 IBT=1,LPM1
  482 BETAM(IBT)=.5*(BETAN(IBT)+BETAN(IBT+1))
  481 CONTINUE
  160 ICPI=0
      WRITE(6,102) ITERA
  102 FORMAT(10X,14HITERATION NO.=,I2)
      DO 650 IRP=1,6
  650 SXSIO(IRP)=SXSI(IRP)
      IF(ITERA.GE.2) STOL=STOLS
      IF(ITERA.EQ.MSTOP) STOL=STOLL
C
C
C
      CALL DXFNEW(SXSI,STOL,MAXIT,ITN,DG,DF,FFF4)
C
C
C
  630 CONTINUE
      DO 537 IO1=1,8
      XSN(IO1)=SXSI(IO1)
  537 WRITE(6,536) IO1,SXSI(IO1)
  536 FORMAT(10X,5HSXSI(,I1,2H)=,E14.7)
      CSPACE=(1.+SXSI(1))/FLOAT(LPK)
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(LPM-LPK)
      HFSPAC=0.5*FSPACE
      XBET=-1.+CSPACE*FLOAT(LPK-1)
      ICPI=1
C ICPI=0 FOR FINDING SXSI(I), I.E., SXSI(I)=YXS(I)& ICPI=1 FOR THE REST.
C CALCULATION OF PRESSURE DISTRIBUTION (CP).
      IF(ITERA.EQ.1) GO TO 36
      DO 35 IB=1,LPM
   35 BETANO(IB)=BETAN(IB)
      DO 37 IB=1,LPM1
   37 BETAMO(IB)=BETAM(IB)
      DO 355 IB=1,LPMM1
  355 BETAO2(IB) = BETAN2(IB)
   36 CONTINUE
      UU2=COS(ALFA1+GAMMA)/COS(SXSI(5)+GAMMA)/ESPACE                    C
C                          )7(ISXS/)AMMAG+)5(ISXS(SOC/)AMMAG+1AFLA(SOC=2UU
      UU22=UU2**2
      UCU1=SQRT(1.+SXSI(6))
      QWU1=UCU1*CAVLEN+UU2*(1.-CAVLEN)
      QWU12=QWU1**2
      CPW=1.-QWU12
      IF (UTAU.EQ.1) CPW=-SXSI(6)*CAVLEN+(1.-UU22)*(1.-CAVLEN)
      DO 25 LQ=1,LPM
      LP=LQ
C FIND CP(XSIP) NEXT.
C----- FOR THE FIRST WETTED ARC PORTION S1-----
C     CP IS BASED  ON U1 AND P1.
```

```
C      LP=1 IS NEAR THE T.E.
C      LP=LPM IS NEAR THE L.E.
       IF(LP.EQ.1)  GO TO 521
       IF(LP.EQ.LPM) GO TO 52
       Q2=EXP(XITN(LP))
C XITN(I) IS CALCULATED IN OFSIM2 OF OXFNEW FOR F(4).
       Q2=Q2**2
       CP(LP)=1.-UU22*Q2
       GO TO 522
   52 CP(LP)=-SXSI(6)
       GO TO 522
  521 CP(LP)=CPW
  522 CONTINUE
   25 CONTINUE
C                                                             EUNITNCC  431
C                                                              .C=)MPL(PC
C                                    )3,021X,PCY,PCX(NEKTIA=)1-MPL(PC
C                                    )3,911X,FCY,PCX(NEKTIA=)2-MPL(PC
C                                                      ECAPSF-)1(ISXS=021X
C                                                   ECAPSF*.2-)1(ISXS=911X
C                                                                .C=)4(PCY
C                                                      )3-MPL(PC=)3(PCY
C                                                      )5-MPL(PC=)2(PCY
C                                                      )7-MPL(PC=)1(PCY
C                                                         )1(ISXS=)4(PCX
C                                                ECAPSF*.2+)2(FCY=)3(PCX
C                                                ECAPSF*.2+)1(PCX=)2(PCX
C                                               ECAPSF*.7-)1(ISXS=)1(PCX
C                                               431 OT OG )1.QE.ARETI(FI
C                                                                           *
C
C**********MAIN INSERT 1****************************************************
C                                                                           *
C                                                                           *
C------CP FOR THE SECOND ARC S2-------
C           NUMBER OF CONTROL POINTS ON S2 IS FIXED
C           IN SUBROUTINE OFSIM5, I.E.,
C              HALF OF THE POINT USED FOR BETA
C           ANSG2S IN COMMON = G2.
       DO 680 NCP = 1,LPMM1
       IF(NCP.EQ.1) GO TO 681
       IF (NCP.EQ.LPMM1) GO TO 682
       Q2 = EXP(ANSG2S(NCP))
       Q2 = Q2**2
       CP2(NCP) = 1.-Q2*UU22
       GO TO 680
  681 CP2(NCP)=-SXSI(6)
       GO TO 680
  682 CP2(NCP)=CPW
  680 CONTINUE
C                                                                           *
C                                                                           *
C**********MAIN INSERT 1****************************************************
C
C
       AF4=ABS(FFF4)
       IF(AF4.GE.SF4) GO TO 1135
       GO TO 1134
 1135 WRITE(6,1136)
 1136 FORMAT(5X,*F(4) IS TOO LARGE TO CALCULATE BETA*)
```

```
      STOP
C FIND XXX(XSIP) FIRST.
 1134 CONTINUE
      IS1S2=0
C-----FIRST BETA FOR ARC 1-----.
      DO 100 LLP=1,LPM
      LP=LPM-LLP+1
      CALL BBBETA(XYX,BETA,IS1S2)
      XXX(LP)=XYX
      BETAN(LP)=BETA
      IF(LP.EQ.LPM) BETAB=BETA
      IF(ITERA.LE.MSTOP1) GO TO 100
      WRITE(6,101) LP,SARC(LP),XXX(LP),CP(LP),BETAN(LP)
  100 CONTINUE
  101 FORMAT(1X,2HI=,I3,1X,5HSARC=,E14.7,1X,4HXXX=,E14.7,1X,3HCP=,E14.7,
     X1X,6HBETAN=,E14.7)
C
C
C*********MAIN INSERT 2*************************************************
C                                                                      *
C                                                                      *
C----------BETA FOR ARC S2------------------------.
C             SARC2 HAS BEEN CALCULATED
C             IN SUBROUTINE OFSIMS AND
C             STORED IN COMMON AREA.
      IS1S2 = 1
      DO 429 LLP=1,LPMM1
      LP=LLP
      CALL BBBETA(XYX,BETA,IS1S2)
      IF(LP.EQ.1) BETAC=BETA
      XXX2(LP) = XYX
      BETAN2(LP) = BETA
      IF(ITERA.LE.MSTOP1) GO TO 329
      WRITE(6,239) LP,SARC2(LP),XXX2(LP),CP2(LP),BETAN2(LP)
  239 FORMAT(9X,*I=*,I3,1X,*SARC2=*,E14.7,1X,*XXX2=*,
     *E14.7,1X,*CP2=*,E14.7,1X,*BETAN2=*,E14.7)
  329 CONTINUE
  429 CONTINUE
C                                                                      *
C                                                                      *
C*********MAIN INSERT 2*************************************************
C
C
C*********MAIN INSERT 3 *************************************************
C                                                                      *
C                                                                      *
C FIND LIFT AND DRAG.
C----------FIRST CL AND CD FOR S1 PART.
      USID = SIN(DELTA)
      UCOD = COS(DELTA)
      UXB = SXSI(4)*UCOD
      UXB2 = UXB**2
      DO 105 ITK = 1,LPM
      IF(ITK.GT.LPK) GO TO 106
      XPS = -1.+CSPACE*FLOAT(ITK-1)
      GO TO 108
  106 XPS = XBET+FSPACE*FLOAT(ITK-LPK)
  108 CONTINUE
      UXA = XPS-SXSI(4)*USID
      UXA2 = UXA**2
```

```
      PXXP = UCOD/(UXA2+UXB2)
      DWDX = DGAP*PXXP*XPS/PAI
      COBET1      = COS(BETAN(ITK))
      SIBET1      = SIN(BETAN(ITK))
      DS1DX = -EXP(-XITN(ITK))*DWDX/UU22
C     G1 IS CALCULATED AT OFSIM2 AS XITN(I).
C     AND STORED IN COMMON.
      IF(XPS.LT.0.) DS1DX = -DS1DX
      XLP1 = DS1DX*CP(ITK)
      FL(ITK) = -XLP1*COBET1
      FD(ITK) = XLP1*SIBET1
  135 CONTINUE
C-----CL AND CD FOR S2 PART.
      NS21=NS2+1
      NS2A=NS2-1
      GAP2 = (SXSI(3)-SXSI(2))/NS2
      DO 338 ITK = 1, NS21
      XRS2 = SXSI(2)+GAP2*(ITK-1)
      UXA = XRS2-SXSI(4)*JSID
      UXA2 = UXA**2
      PXXP = UCOD/(UXA2+UXB2)
      DWDX = DGAP*PXXP*XRS2/PAI
      COBET2 =-COS(BETAN2(ITK))
      SIBET2 =-SIN(BETAN2(ITK))
      DS2DX = EXP(-ANSG2S(ITK))*DWDX/UU22
C     S2 IS ALREADY CALCULATED AT OFSIM5 AS
C     ANSG2S(I), STORED IN COMMON AREA.
      XLP2 =  DS2DX*CP2(ITK)
      FL2(ITK) =-XLP2*COBET2
      FD2(ITK) =  XLP2*SIBET2
  338 CONTINUE
      SPACE = CSPACE
      CLIFT = 0.5*CSPACE*FL(2)+0.5*FSPACE*FL(LPM1)
      CDRAG = 0.5*CSPACE*FD(2)+0.5*FSPACE*FD(LPM1)
      DO 111 IUA = 2,LPM3,2
      IF(IUA.GE.LPK) SPACE = FSPACE
      CLIFT = CLIFT+SPACE*(FL(IUA)+4.*FL(IUA+1)+FL(IUA+2))/3.
  111 CDRAG = CDRAG+SPACE*(FD(IUA)+4.*FD(IUA+1)+FD(IUA+2))/3.
      DO 321 IUA = 1,NS2A,2
      CLIFT = CLIFT+GAP2*(FL2(IUA)+4.*FL2(IUA+1)+FL2(IUA+2))/3.
  321 CDRAG = CDRAG+GAP2*(FD2(IUA)+4.*FD2(IUA+1)+FD2(IUA+2))/3.
C-----ADD THE FORCES ON CAVITY PORTIONS.
C     SUBROUTINE XCYC CALCULATES
C   THE POINT ON THE UPPER BLADE PORTION CORRESP. TO THE CAVITY END POINT.
      CXA=XCCC
      CYA=YCCC
      CALL XCYC(XCCCB,YCCCB,CXA,CYA)
      CLIFT = CLIFT+SXSI(6)*XCCCB
      CDRAG = CDRAG-SXSI(6)*YCCCB
C-----ADJUST CDRAG FOR THE BASE PRESSURE PW.
      CDRAG=CDRAG-CPW*THBL
C-----XCCC AND YCCC ARE THE END POINTS OF CAVITY, CALCULATED IN
C     SUBROUTINE CAVITY
C     STORED IN COMMON.
C                                                                              *
C                                                                              *
C**********MAIN INSERT 3 ************************************************
C
C
C FIND BINF IN 2-1.
```

```
      U2U1=COS(ALFA1+GAMMA)/COS(SXSI(5)+GAMMA)/ESPACE
      DOWN=COS(ALFA1+GAMMA)+COS(SXSI(5)+GAMMA)
      BINF=0.5*SIN(ALFA1+SXSI(5)+2.*GAMMA)/DOWN
      BINF=ATAN(1./BINF)
      AINF=0.5*PAI-BINF-GAMMA
C CDSTAR AND ALSTAR ARE BASED ON VELOCITY AT UPSTREAM INFINITY IN (X,Y).
      CDSTAR=CDRAG
      CLSTAR=CLIFT
      UINF=0.5*SQRT(1.+U2U1**2+2.*U2U1*COS(ALFA1-SXSI(5)))
      FINF=2.*DGAP*SIN(ALFA1-SXSI(5))/(UINF*COS(SXSI(5)+GAMMA))
      CLINF=CLSTAR*COS(AINF)-CDSTAR*SIN(AINF)
      CDINF=CLSTAR*SIN(AINF)+CDSTAR*COS(AINF)
      CLINF=CLINF/UINF**2
      CDINF=CDINF/UINF**2
      WRITE(6,117) CLINF,CDINF
  117 FORMAT(1X,34HCLINF OR CDINF=FORCE/1/2RO.UINF**2,5X,6HCLINF=,E14.7,
     X1X,6HCDINF=,E14.7)
      WRITE(6,118) FINF
  118 FORMAT(1X,34HFINF IS OBTAINED FROM MOMENTUM EQN,5HFINF=,E14.7)
      WRITE(6,221)
  221 FORMAT(1X,48H---CCLL & CCDD ARE BASED ON U1 IN ALFA1 DIRE.---)
      CCLL=CLSTAR*COS(ALFA1)-CDSTAR*SIN(ALFA1)
      CCDD=CLSTAR*SIN(ALFA1)+CDSTAR*COS(ALFA1)
      ALOD=CCLL/CCDD
      WRITE(6,181) CCDD,CCLL,ALOD,U2U1
  181 FORMAT(1X,5HCCDD=,E14.7,1X,5HCCLL=,E14.7,1X,4HL/D=,E14.7,1X,
     X         5HU2U1=,E14.7)
      MSTOP1=MSTOP-1
      IF(ITERA.LE.MSTOP1) GO TO 140
C
C
C**********MAIN INSERT 4 ************************************************
C                                                                        *
C                                                                        *
C     CAVITY SHAPE.
C        ALREADY CALCULATED IN
C        SUBROUTINE CAVITY.
      WRITE(6,287)
  287 FORMAT(2X,*----CAVITY SHAPE------*)
      NCAV1=NCAV+1
      DO 285 KCAV=1,NCAV1,2
  285 WRITE(6,286) CAVX(KCAV ),CAVY(KCAV )
  286 FORMAT(10X,*X=*,E14.7,10X,*Y=*,E14.7)
C                                                                        *
C                                                                        *
C**********MAIN INSERT 4 ************************************************
C
C
  140 CONTINUE
      XCCC=0.
      YCCC=0.
      WRITE(6,923)
  923 FORMAT(//,*-----------UPPER BODY SHAPE----------*)
      DO 921 ISHP=1,51
      X=.02*(ISHP-1)
      CALL SHAPE (X,Y,BETA,3)
  921 WRITE(6,922) X,Y
  922 FORMAT(5X,*X=*,F10.5,2X,*Y=*,F10.5)
      REWIND 7
      WRITE(7,768) (SXSI(KX),KX=1,8)
```

```
  766 FORMAT(8F10.7)
      DO 766 IC=1,LPM
  766 WRITE(7,767) SARC(IC),BETAN(IC)
  767 FORMAT(2E14.7)
      DO 1766 IC=1,LPMM1
 1766 WRITE(7,767) SARC2(IC),BETAN2(IC)
      IF(ITERA.GE.MSTOP) GO TO 999
      LPK1=LPK-1
      SPACE=CSPACE
      HSPACE=HCSPAC
      DO 50 IM=1,LPM1
      IF(IM.EQ.1) GO TO 51
      IF(IM.EQ.LPM1) GO TO 55
      IF(IM.EQ.LPK1) GO TO 97
      IF(IM.EQ.LPK) GO TO 98
      IF(IM.GT.LPK) GO TO 93
      XY=-1.+SPACE*FLOAT(IM-1)+HSPACE
      XZ(1)=-1.+SPACE*FLOAT(IM-2)
      XZ(2)=XZ(1)+SPACE
      XZ(3)=XZ(2)+SPACE
      XZ(4)=XZ(3)+SPACE
      GO TO 99
   93 SPACE=FSPACE
      HSPACE=HFSPAC
      XY=XSET+HSPACE+ SPACE*FLOAT(IM-LPK)
      XZ(1)=XSET+SPACE*FLOAT(IM-LPK-1)
      XZ(2)=XZ(1)+SPACE
      XZ(3)=XZ(2)+SPACE
      XZ(4)=XZ(3)+SPACE
   99 DO 56 IK=1,4
   56 YBE(IK)=BETAN(IM+IK-2)
      BETAM(IM)=AITKEN(XZ,YBE,XY,3)
      GO TO 151
   97 BETAM(LPK1)=0.5*(BETAN(LPK1)+BETAN(LPK))
      GO TO 151
   98 BETAM(LPK)=0.5*(BETAN(LPK)+BETAN(LPK+1))
      GO TO 151
   51 BETAM(1)=0.5*(BETAN(1)+BETAN(2))
      GO TO 151
   55 BETAM(LPM1)=0.5*(BETAN(LPM1)+BETAN(LPM))
  151 CONTINUE
   50 CONTINUE
      IF(ITERA.EQ.1) GO TO 6
      DO 41 IE=1,LPM
   41 BETAN(IE)=BETAN(IE)*(1.-XXM)+BETAN0(IE)*XXM
      DO 42 IFG=1,LPM1
   42 BETAM(IFG)=BETAM(IFG)*(1.-XXM)+BETAM0(IFG)*XXM
      DO 425 IFG=1,LPMM1
  425  BETAN2(IFG) = BETAN2(IFG)*(1.-XXM)+BETAO2(IFG)*XXM
      DO 852 IRP=1,8
  852 SXSI(IRP)=SXSI(IRP)*(1.-XXM)+SXSI0(IRP)*XXM
    6 ITERA=ITERA+1
      IF(ITERA.GT.MSTOP) GO TO 28
      GO TO 160
   28 WRITE(6,29)
   29 FORMAT(5X,26HITERATION WAS TERMINATED.)
  999 CONTINUE
      STOP
      END
```

```
      SUBROUTINE DXFNEW(X,STOL,M,I,DG,DF,FFF4)
      DIMENSION F(8),P(50,8),X(8),Q(6,8),XRRI(8),XMMI(8)
      COMMON/DELTAD/DELT(8,8)
      COMMON /CNTYL/CAV_EN,BIGS2
      COMMON/FREECAV/XFREEC,YFREEC
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,_PMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,A_FA1,GAMMA
      COMMON       SBETA,KKK,ICPI,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSV(8),     DLE,ERC,YYY,XM,ITERA,SXSIO(8),SXSIOO(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BC,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      COMMON/SPC/ESPACE
      COMMON/TAU1/JTAU
      PAI=3.141592653
      I=0
      IF(ITERA._E.3) GO TO 272
      DO 67 IIJ=1,8
   67 WRITE(6,66) IIJ,X(IIJ)
   66 FORMAT(1X,24HX(,I1,24)=,E14.7)
  272 CONTINUE
      SI7=-1.-2.*DE_T(7,1)
   55 SI1=2.*DE
      SI6=2.*DG
      IF (X(7).GT.SI7) X(7)=SI7
      IF(X(1).LT.SI1) X(1)=SI1
      SI10=X(1)+2.*DG
      IF(X(2).LT.SI10) X(2)=SI10
      SI11=X(2)+2.*DG
      IF(X(3).LT.SI11) X(3)=SI11
      SI8=X(3)+2.*DELT(8,1)
      IF (X(8)._T.SI8) X(8)=SI8
      IF(X(4).LT.SI6) X(4)=SI6
      SI5=(0.5*PAI-GAMMA)*(1.-0.02)
      IF(X(5).LT.0.) GO TO 78
      IF(X(5).GT.SI5) X(5)=SI5
      GO TO 79
   78 IF(ABS(X(5)).GT.SI5) X(5)=-SI5
   79 CONTINUE
      IF(X(6).LE..001) X(6)=.001
      DO 68 IIJ=1,8
   68 WRITE(6,66) IIJ,X(IIJ)
      IJ=1
C------F(1)-----------------------------------------------------------------
      DO 20 IK=1,8
   20 YXS(IK)=X(IK)
    5 CONTINUE
      KCTRL = 1
      CALL F1INTL(YINT1,KCTRL)
C     SUBROUTINE F1INTL CALCULATES THE INTEGRALS IN F(1).
      KCTRL = 2
      CALL F1INTL (YINT2,KCTRL)
      KCTRL = 3
      CALL F1INTL (YINT3,KCTRL)
      KCTRL = 4
```

```
      CALL F1INTL (YINT4,KCTRL)
      KCTRL=5
      CALL F1INTL(YINT5,KCTRL)
      KCTRL=6
      CALL F1INTL(YINT6,KCTRL)
      CCC1=ALOG(1.+YXS(6))/(2.*PAI)
      CS1=ALOG(COS(YXS(5)+GAMMA)/COS(ALFA1+GAMMA)*ESPACE)
      SSG=SQRT(1.+YXS(6))
      U2=COS(ALFA1+GAMMA)/COS(YXS(5)+GAMMA)/ESPACE
      U22=U2**2
      U22I=1./U22
      TW0=SSG*CAVLEN/U2+(1.-CAVLEN)
      TAUW0=ALOG(TW0)
      TW1=SQRT(1.-(1.-YXS(6)-U22I)*CAVLEN)
      TAUW1=ALOG(TW1)
      IF (UTAU.EQ.0) TAUW=TAUW0
      IF (UTAU.EQ.1) TAUW=TAUW1
      FA = -(YINT1/PAI+YINT2-(CCC1+CS1/PAI)*YINT3
     1+YINT4/PAI-YXS(5)+TAUW*(YINT5-YINT6)/PAI)
      IF (IJ.EQ.1) WRITE (6,70) YINT1,YINT2,YINT3,YINT4
   70 FORMAT (10X,'---I1,I2,I3,I4 OF F(1) ARE---',4(E14.7,2X))
      IF (IJ.EQ.1) F(1) = FA
      IF (IJ.EQ.2) GO TO 3
      IF (IJ.EQ.3) GO TO 4
      IF (IJ.EQ.4) GO TO 320
      IF (IJ.EQ.5) GO TO 321
      IF (IJ.EQ.6) GO TO 322
      IF(IJ.EQ.66) GO TO 3222
      IF (IJ.EQ.400) GO TO 400
      IF (IJ.EQ.401) GO TO 401
      IF (IJ.EQ.402) GO TO 402
      IF (IJ.EQ.443) GO TO 443
      TY5=TAN(YXS(5)+GAMMA)
      DTWDA=-TY5*CAVLEN*SSG/TW0/U2
      IF (UTAU.EQ.1) DTWDA=-CAVLEN*TY5/U22/(TW1**2)
      DTWDS=.5/U2*CAVLEN/SSG/TW0
      IF (UTAU.EQ.1) DTWDS=0.5*CAVLEN/(TW1**2)
      P(1,5) = TAN(YXS(5)+GAMMA)*YINT3/PAI-1.*(YINT5-YINT6)/PAI*DTWDA
      P(1,6)=-YINT3/(2.*PAI*(1.+YXS(6)))+(YINT5-YINT6)/PAI*DTWDS
      IJ = 2
      YXS(1) = X(1)+DELT(1,1)
      GO TO 5
    3 F1P = -FA
      IJ = 3
      YXS(1) = X(1)-DELT(1,1)
      GO TO 5
    4 F1Q = -FA
      P(1,1) = (F1P-F1Q)/(2.*DELT(1,1))
      IJ = 4
      YXS(1) = X(1)
      YXS(2) = X(2)+DELT(1,2)
      GO TO 5
  320 F1P = -FA
      YXS(2) = X(2)-DELT(1,2)
      IJ = 5
      GO TO 5
  321 F1Q = -FA
      P(1,2) = (F1P-F1Q)/(2.*DELT(1,2))
      YXS(2) = X(2)
      YXS(3) = X(3)+DELT(1,3)
```

```
      IJ = 6
      GO TO 5
  322 F1P = -FA
      IJ=66
      YXS(3)=X(3)-DELT(1,3)
      GO TO 5
 3222 F1Q=-FA
      YXS(3)=X(3)
      P(1,3) = (F1P-F1Q)/(2.*DELT(1,3))
      P(1,4) = 0.
      IJ=400
      ABSX7=ABS(X(7))
      YXS(7)=X(7)+DELT(1,7)*ABSX7
      GO TO 5
  400 F1P=-FA
      IJ=401
      YXS(7)=X(7)-DELT(1,7)*ABSX7
      GO TO 5
  401 F1Q=-FA
      P(1,7)=(F1P-F1Q)/(2.*DELT(1,7)*ABSX7)
      YXS(7)=X(7)
      IJ=402
      YXS(8)=X(8)+DELT(1,8)
      GO TO 5
  402 F1P=-FA
      IJ=443
      YXS(8)=X(8)-DELT(1,8)
      GO TO 5
  443 F1Q=-FA
      P(1,8)=(F1P-F1Q)/(2.*DELT(1,8))
      YXS(8)=X(8)
C-----F(2) AND F(3)-------------------------------------------------------
      IJ = 7
  330 CONTINUE
      XKKX=ALOG(COS(ALFA1+GAMMA)/COS(YXS(5)+GAMMA)/ESPACE)
C                    ))7(SXY/)AMMA3+)5(SXY(SOC/)AMMA3+1AFLA(SOC(GCLA = X<KX
      XX1  = YXS(4)*SIN(DE_TA)
      YY1  = YXS(4)*COS(DE_TA)
      YY12=YY1**2
      CCC1=ALOG(1.+YXS(6))/(2.*PAI)
      CON1 = CCC1-XKKX/PAI
      XRR = 0.
      XMM = 0.
      DO 331 MIQ = 1,6
      CALL RMINT(SOLNR,SOLNM,MIQ)
      XRRI(MIQ) = SOLNR
      XMMI (MIQ) = SOLNM
      XRRR = -XRRI(MIQ)/PAI
      XMMM = -XMMI(MIQ)/PAI
      IF (MIQ.EQ.1) XRRR = CON1*XRRI(MIQ)
      IF (MIQ.EQ.1) XMMM = CON1*XMMI(MIQ)
      IF (MIQ.EQ.4) XRRR = -XRRI(MIQ)
      IF (MIQ.EQ.4) XMMM = -XMMI(MIQ)
      IF (MIQ.EQ.5) XRRI(MIQ)=-XRRI(MIQ)/PAI
      IF (MIQ.EQ.5) XMMI(MIQ)=-XMMI(MIQ)/PAI
      IF (MIQ.EQ.6) XRRI(MIQ)=XRRI(MIQ)/PAI
      IF (MIQ.EQ.6) XMMI(MIQ)=XMMI(MIQ)/PAI
      IF ((JTAU.EQ.0).AND.(MIQ.GE.5))       XRRR=XRRI(MIQ)*TAU#0
      IF ((JTAU.EQ.0).AND.(MIQ.GE.5))       XMMM=XMMI(MIQ)*TAUW0
      IF ((JTAU.EQ.1).AND.(MIQ.GE.5))       XRRR=XRRI(MIQ)*TAU#1
```

```
      IF ((JTAU.EQ.1).AND.(MIQ.GE.5))       XMMM=XMMI(MIQ)*TAUM1
      IF (IJ.EQ.7) WRITE (6,71) (XRRI(I),I=1,4)
      IF (IJ.EQ.7) WRITE (6,72) (XMMI(I),I=1,4)
   71 FORMAT(10X,'----XRRI(I),I=1,4 OF F(2) AND F(3) ARE----',4(E14.7,2X))
   72 FORMAT(10X,'----XMMI(I),I=1,4 OF F(2) AND F(3) ARE----',4(E14.7,2X))
      XRR = XRR+XRRR
      XMM = XMM+XMMM
  331 CONTINUE
C-----CALCULATION OF H1(ZETA1)-------.
      XSIP1 = XX1+1.
      XSIMB = XX1-YXS(1)
      XSIMF = XX1-YXS(3)
      XSIMC = XX1-YXS(2)
      XSIP12 = XSIP1**2
      XSIMB2 = XSIMB**2
      XSIMF2 = XSIMF**2
      XSIMC2 = XSIMC**2
      RRA = SQRT(XSIP12+YY12)
      RRB = SQRT(XSIMB2+YY12)
      RRC = SQRT(XSIMF2+YY12)
      RRD = SQRT(XSIMC2+YY12)
      THIA = ATAN(YY1/XSIP1)
      IF (XSIP1.LE.0.) THIA = PAI+THIA
      THIB = ATAN(YY1/XSIMB)
      IF (XSIMB.LE.0.) THIB = PAI+THIB
      THIC = ATAN(YY1/XSIMF)
      IF (XSIMF.LE.0.) THIC = PAI+THIC
      THID = ATAN(YY1/XSIMC)
      IF (XSIMC.LE.0.) THID = PAI+THID
      RR1 = SQRT(RRA*RRB*RRC/RRD)
      THIT1 = .5*(THIA+THIB+THIC-THID)
      COTH1 = COS(THIT1)
      SITH1 = SIN(THIT1)
      F2CO = RR1*(XRR*COTH1-XMM*SITH1)-ALFA1
      F3CO = RR1*(XRR*SITH1+XMM*COTH1)+XKKX
      IF (IJ.EQ.7) F(2) = -F2CO
      IF (IJ.EQ.7) F(3) = -F3CO
      IF (IJ.EQ.8) GO TO 340
      IF (IJ.EQ.9) GO TO 341
      IF (IJ.EQ.10) GO TO 342
      IF (IJ.EQ.11) GO TO 343
      IF (IJ.EQ.12) GO TO 344
      IF (IJ.EQ.13) GO TO 345
      IF (IJ.EQ.14) GO TO 346
      IF (IJ.EQ.15) GO TO 347
      IF (IJ.EQ.403) GO TO 403
      IF (IJ.EQ.404) GO TO 404
      IF (IJ.EQ.405) GO TO 405
      IF (IJ.EQ.406) GO TO 406
      TA2G =  TAN(YXS(5)+GAMMA)
      XCXS= XRRI(1)*COTH1 - XMMI(1)*SITH1
      XSXC= XRRI(1)*SITH1 + XMMI(1)*COTH1
      RC1=RR1*COTH1
      RS1=RR1*SITH1
      XR56=XRRI(5)+XRRI(6)
      XM56=XMMI(5)+XMMI(6)
      RR56=RC1*XR56-RS1*XM56
      RM56=RC1*XM56+RS1*XR56
      P(2,5) = -RR1*TA2G*XCXS
      P(2,5) = P(2,5)/PAI+RR56*DTWDA
```

```
      P(3,5) = -RR1*TA2G*XSXC
      P(3,5) = P(3,5)/PAI*TA2G+RM56*DTWDA
      BPY=2.*PAI*(1.+YXS(5))
      P(2,6)=RR1*(XRRI(1)*COTH1-XMMI(1)*SITH1)/BPY+RR56*DTWDS
      P(3,6)=RR1*(XRRI(1)*SITH1+XMMI(1)*COTH1)/BPY+RM56*DTWDS
      IJ = 8
      YXS(1) = X(1)+DELT(1,2)
      GO TO 330
  340 FP2 = F2CO
      FP3 = F3CO
      IJ = 9
      YXS(1) = X(1)-DELT(2,1)
      GO TO 330
  341 P(2,1) = (FP2-F2CO)/(2.*DELT(2,1))
      P(3,1) = (FP3-F3CO)/(2.*DELT(2,1))
      YXS(1) = X(1)
      YXS(2) = X(2)+DELT(2,2)
      IJ = 10
      GO TO 330
  342 FP2 = F2CO
      FP3 = F3CO
      YXS(2) = X(2)-DELT(2,2)
      IJ=11
      GO TO 330
  343 P(2,2) = (FP2-F2CO)/(2.*DELT(2,2))
      P(3,2) = (FP3-F3CO)/(2.*DELT(2,2))
      YXS(2) = X(2)
      YXS(3) =   X(3)+DELT(2,3)
      IJ = 12
      GO TO 330
  344 FP2 = F2CO
      FP3 = F3CO
      YXS(3) = X(3)-DELT(2,3)
      IJ = 13
      GO TO 330
  345 P(2,3) = (FP2-F2CO)/(2.*DELT(2,3))
      P(3,3) = (FP3-F3CO)/(2.*DELT(2,3))
      YXS(4) = X(4)+DELT(2,4)
      YXS(3)=X(3)
      IJ=14
      GO TO 330
  346 FP2=F2CO
      FP3=F3CO
      YXS(4) = X(4)-DELT(2,4)
      IJ = 15
      GO TO 330
  347 P(2,4) = (FP2-F2CO)/(2.*DELT(2,4))
      P(3,4) = (FP3-F3CO)/(2.*DELT(2,4))
      YXS(4)=X(4)
      IJ=403
      YXS(7)=X(7)+DELT(2,7)*ABSX7
      GO TO 330
  403 FP2=F2CO
      FP3=F3CO
      YXS(7)=X(7)-DELT(2,7)*ABSX7
      IJ=404
      GO TO 330
  404 P(2,7)=(FP2-F2CO)/(2.*DELT(2,7)*ABS(7)
      P(3,7)=(FP3-F3CO)/(2.*DELT(3,7)*ABSX7)
      YXS(7)=X(7)
```

```
      IJ=405
      YXS(8)=X(8)+DELT(2,8)
      GO TO 330
  405 FP2=F2CO
      FP3=F3CO
      IJ=406
      YXS(8)=X(8)-DELT(2,8)
      GO TO 330
  406 P(2,8)=(FP2-F2CO)/(2.*DELT(2,8))
      P(3,8)=(FP3-F3CO)/(2.*DELT(3,8))
      YXS(8)=X(8)
C-----F(4)-------------------------------------------------------------
      IJ=16
      YXS(1)=X(1)+DELT(4,1)
  199 CALL OFSIM2(ANS2)
      IF(IJ.EQ.16) GO TO 513
      IF(IJ.EQ.17) GO TO 514
      IF(IJ.EQ.18) GO TO 575
      IF(IJ.EQ.19) GO TO 515
      IF(IJ.EQ.20) GO TO 516
      IF(IJ.EQ.21) GO TO 517
      IF(IJ.EQ.22) GO TO 518
      IF(IJ.EQ.23) GO TO 521
      IF(IJ.EQ.24) GO TO 522
      IF(IJ.EQ.25) GO TO 523
      IF(IJ.EQ.26) GO TO 524
      IF(IJ.EQ.261) GO TO 5241
      IF(IJ.EQ.262) GO TO 5242
      IF (IJ.EQ.407) GO TO 407
      IF (IJ.EQ.408) GO TO 408
      IF (IJ.EQ.409) GO TO 409
      IF (IJ.EQ.410) GO TO 410
  513 ANSP=ANS2
      IJ=17
      YXS(1)=X(1)-DELT(4,1)
      GO TO 199
  514 ANSQ=ANS2
      IJ=18
      P(4,1)=-(ANSP-ANSQ)/(2.*DELT(4,1))
      YXS(1)=X(1)
      GO TO 199
  575 ANSF=ANS2
      F(4)=-(BIGS-ANSF)
      IJ=19
      YXS(2)=X(2)+DELT(4,2)*ABS(X(2))
      GO TO 199
  515 ANSPP=ANS2
      IJ=20
      YXS(2)=X(2)-DELT(4,2)*ABS(X(2))
      GO TO 199
  516 ANSQQ=ANS2
      P(4,2)=-(ANSPP-ANSQQ)/(2.*DELT(4,2)*ABS(X(2)))
      YXS(2)=X(2)
      IJ=21
      YXS(3)=X(3)+DELT(4,3)*X(3)
      GO TO 199
  517 ANS1P=ANS2
      IJ=22
      YXS(3)=X(3)-DELT(4,3)*X(3)
      GO TO 199
```

```
  613 ANS1Q=ANS2
      P(4,3)=-(ANS1P-ANS1Q)/(2.*DELT(4,3)*X(3))
      YXS(3)=X(3)
      IJ=23
      YXS(4)=X(4)+DELT(4,4)*ABS(X(4))
      GO TO 199
  621 ANA=ANS2
      IJ=24
      YXS(4)=X(4)-DELT(4,4)*ABS(X(4))
      GO TO 199
  622 ANB=ANS2
      P(4,4)=-(ANA-ANB)/(2.*DELT(4,4)*ABS(X(4)))
      YXS(4)=X(4)
      IJ=25
      YXS(5)=X(5)+DELT(4,5)
      GO TO 199
  623 BNA=ANS2
      IJ=26
      YXS(5)=X(5)-DELT(4,5)
      GO TO 199
  624 BNB=ANS2
      P(4,5)=-(BNA-BNB)/(2.*DELT(4,5))
      YXS(5)=X(5)
      F(4)=F(4)
      YXS(5) = X(5)
      YXS(6)=X(6)+DELT(4,6)
      IJ=261
      GO TO 199
 6241 BNA=ANS2
      IJ=262
      YXS(6)=X(6)-DELT(4,6)
      GO TO 199
 6242 BNB=ANS2
      P(4,6)=-(BNA-BNB)/(2.*DELT(4,6))
      YXS(6)=X(6)
      IJ=407
      YXS(7)=X(7)+DELT(4,7)*ABSX7
      GO TO 199
  407 ANA=ANS2
      YXS(7)=X(7)-DELT(4,7)*ABSX7
      IJ=408
      GO TO 199
  408 ANB=ANS2
      P(4,7)=-(ANA-ANB)/(2.*DELT(4,7)*ABSX7)
      YXS(7)=X(7)
      YXS(8)=X(8)+DELT(4,8)
      IJ=409
      GO TO 199
  409 ANA=ANS2
      IJ=410
      YXS(8)=X(8)-DELT(4,8)
      GO TO 199
  410 ANB=ANS2
      P(4,8)=-(ANA-ANB)/(2.*DELT(4,8))
      YXS(8)=X(8)
C-----F(5) AND F(7)-----------------------------------------------------
C   THIS SUBROUTINE FINDS THE END POINT OF CAVITY.
      IJ = 27
  815 CALL CAVITY (XCEND,YCEND)
      IS1I2=3
```

```
      CALL SHAPE(XCEND,YUPPER,BETA,IS1I2)
      IF(IJ.EQ.27) GO TO 820
      IF(IJ.EQ.28) GO TO 821
      IF (IJ.EQ.29) GO TO 822
      IF (IJ.EQ.30) GO TO 823
      IF (IJ.EQ.31) GO TO 824
      IF (IJ.EQ.32) GO TO 825
      IF (IJ.EQ.33) GO TO 826
      IF (IJ.EQ.34) GO TO 827
      IF(IJ.EQ.341) GO TO 830
      IF (IJ.EQ.35) GO TO 828
      IF (IJ.EQ.36) GO TO 829
      IF(IJ.EQ.37) GO TO 840
      IF(IJ.EQ.38) GO TO 841
      IF (IJ.EQ.411) GO TO 411
      IF (IJ.EQ.412) GO TO 412
      IF (IJ.EQ.413) GO TO 413
      IF (IJ.EQ.414) GO TO 414
  820 F(5)=-(XCEND-CAVLEN)
      F(7) = -(YCEND-YUPPER)
      IJ = 29
      YXS(1) = X(1)+DELT(5,1)
      GO TO 815
  821 ANP=XCEND
      ANP7=YCEND-YUPPER
      IJ = 29
      YXS(1) = X(1)-DELT(5,1)
      GO TO 815
  822 P(5,1)=(ANP-XCEND)/(2.*DELT(5,1))
      ANG7=YCEND-YUPPER
      P(7,1) = (ANP7-ANG7)/(2.*DELT(5,1))
      YXS(1) = X(1)
      YXS(2) = X(2)+DELT(5,2)*ABS(X(2))
      IJ = 30
      GO TO 815
  823 ANP=XCEND
      ANP7=YCEND-YUPPER
      YXS(2) = X(2)-DELT(5,2)*ABS(X(2))
      IJ = 31
      GO TO 815
  824 P(5,2)=(ANP-XCEND)/(2.*DELT(5,2)*ABS(X(2)))
      ANG7=YCEND-YUPPER
      P(7,2) = (ANP7-ANG7)/(2.*DELT(5,2)*ABS(X(2)))
      YXS(2) = X(2)
      IJ = 32
      YXS(3) = X(3)+DELT(5,3)*X(3)
      GO TO 815
  825 ANP=XCEND
      ANP7=YCEND-YUPPER
      YXS(3) = X(3)-DELT(5,3)*X(3)
      IJ = 33
      GO TO 815
  826 P(5,3)=(ANP-XCEND)/(2.*DELT(5,3)*X(3))
      ANG7=YCEND-YUPPER
      P(7,3) = (ANP7-ANG7)/(2.*DELT(5,3)*X(3))
      IJ = 34
      YXS(3) = X(3)
      YXS(4) = X(4)+DELT(5,4)*ABS(X(4))
      GO TO 815
  827 ANP=XCEND
```

```
      ANP7=YCEND-YUPPER
      YXS(4) = X(4)-DELT(5,4)*ABS(X(4))
      IJ=341
      GO TO 815
  850 CONTINUE
      P(6,4)=(ANP-XCEND)/(2.*DELT(5,4)*ABS(X(4)))
      ANQ7=YCEND-YUPPER
      P(7,4) = (ANP7-ANQ7)/(2.*DELT(5,4)*ABS(X(4)))
      YXS(4) = X(4)
      YXS(5) = X(5)+DELT(5,5)
      IJ = 35
      GO TO 815
  825 ANP=XCEND
      ANP7=YCEND-YUPPER
      YXS(5) = X(5)-DELT(5,5)
      IJ =36
      GO TO 815
  826 P(6,5)=(ANP-XCEND)/(2.*DELT(5,5))
      ANQ7=YCEND-YUPPER
      P(7,5) = (ANP7-ANQ7)/(2.*DELT(5,5))
      YXS(5)=X(5)
      YXS(6)=X(6)+DELT(5,6)
      IJ=37
      GO TO 815
  840 ANP=XCEND
      ANP7=YCEND-YUPPER
      YXS(6)=X(6)-DELT(5,6)
      IJ=38
      GO TO 815
  841 P(6,6)=(ANP-XCEND)/(2.*DELT(5,6))
      ANQ7=YCEND-YUPPER
      P(7,6) = (ANP7-ANQ7)/(2.*DELT(5,6))
      YXS(6)=X(6)
      IJ=411
      YXS(7)=X(7)+DELT(5,7)*ABSX7
      GO TO 815
  411 ANP=XCEND
      ANP7=YCEND-YUPPER
      IJ=412
      YXS(7)=X(7)-DELT(5,7)*ABSX7
      GO TO 815
  412 P(6,7)=(ANP-XCEND)/(2.*DELT(5,7)*ABSX7)
      ANQ7=YCEND-YUPPER
      P(7,7)=(ANP7-ANQ7)/(2.*DELT(5,7)*ABSX7)
      YXS(7)=X(7)
      IJ=413
      YXS(8)=X(8)+DELT(5,8)
      GO TO 815
  413 ANP=XCEND
      ANP7=YCEND-YUPPER
      IJ=414
      YXS(8)=X(8)-DELT(5,8)
      GO TO 815
  414 P(6,8)=(ANP-XCEND)/(2.*DELT(5,8))
      ANQ7=YCEND-YUPPER
      P(7,8)=(ANP7-ANQ7)/(2.*DELT(5,8))
      YXS(8)=X(8)
C--------F(6)--------
      IJ=40
  850 CALL OFSI45(ANS5)
```

```
      IF(IJ.EQ.40) GO TO 851
      IF(IJ.EQ.41) GO TO 852
      IF(IJ.EQ.42) GO TO 853
      IF(IJ.EQ.43) GO TO 854
      IF(IJ.EQ.44) GO TO 855
      IF(IJ.EQ.45) GO TO 856
      IF(IJ.EQ.46) GO TO 857
      IF(IJ.EQ.47) GO TO 858
      IF(IJ.EQ.48) GO TO 859
      IF(IJ.EQ.49) GO TO 860
      IF(IJ.EQ.50) GO TO 861
      IF(IJ.EQ.51) GO TO 862
      IF(IJ.EQ.52) GO TO 863
      IF (IJ.EQ.415) GO TO 415
      IF (IJ.EQ.416) GO TO 416
      IF (IJ.EQ.417) GO TO 417
      IF (IJ.EQ.418) GO TO 418
  851 F(6)=-(ANS5-BIGS2)
      IJ=41
      YXS(1)=X(1)+DELT(6,1)
      GO TO 850
  852 ANP=ANS5
      IJ=42
      YXS(1)=X(1)-DELT(6,1)
      GO TO 850
  853 P(6,1)=(ANP-ANS5)/(2.*DELT(6,1))
      YXS(1)=X(1)
      IJ=43
      YXS(2)=X(2)+DELT(6,2)
      GO TO 850
  854 ANP=ANS5
      IJ=44
      YXS(2)=X(2)-DELT(6,2)
      GO TO 850
  855 P(6,2)=(ANP-ANS5)/(2.*DELT(6,2))
      IJ=45
      YXS(2)=X(2)
      YXS(3)=X(3)+DELT(6,3)
      GO TO 850
  856 ANP=ANS5
      IJ=46
      YXS(3)=X(3)-DELT(6,3)
      GO TO 850
  857 P(6,3)=(ANP-ANS5)/(2.*DELT(6,3))
      IJ=47
      YXS(3)=X(3)
      YXS(4)=X(4)+DELT(6,4)
      GO TO 850
  858 ANP=ANS5
      IJ=48
      YXS(4)=X(4)-DELT(6,4)
      GO TO 850
  859 P(6,4)=(ANP-ANS5)/(2.*DELT(6,4))
      IJ=49
      YXS(4)=X(4)
      YXS(5)=X(5)+DELT(6,5)
      GO TO 850
  860 ANP=ANS5
      IJ=50
      YXS(5)=X(5)-DELT(6,5)
```

```
      GO TO 850
  851 P(6,5)=(ANP-ANS5)/(2.*DELT(5,5))
      YXS(5)=X(5)
      YXS(6)=X(6)+DELT(6,5)
      IJ=51
      GO TO 850
  852 ANP=ANS5
      YXS(6)=X(6)-DELT(6,5)
      IJ=52
      GO TO 850
  853 P(6,6)=(ANP-ANS5)/(2.*DELT(6,6))
      YXS(6)=X(6)
      YXS(7)=X(7)+DELT(6,7)*ABSX7
      IJ=415
      GO TO 850
  415 ANP=ANS5
      YXS(7)=X(7)-DELT(6,7)*ABSX7
      IJ=416
      GO TO 850
  416 P(6,7)=(ANP-ANS5)/(2.*DELT(6,7)*ABS(7)
      YXS(7)=X(7)
      YXS(8)=X(8)+DELT(6,8)
      IJ=417
      GO TO 850
  417 ANP=ANS5
      YXS(8)=X(8)-DELT(6,8)
      IJ=418
      GO TO 850
  418 P(6,8)=(ANP-ANS5)/(2.*DELT(6,8))
      YXS(8)=X(8)
C----F(8)----------
      SID=SIN(DELTA)
      COD=COS(DELTA)
      CSA=YXS(4)*SID-YXS(7)
      CSB=YXS(4)*COD
      DSA=YXS(4)*SID-YXS(8)
      DSB=YXS(4)*COD
      CSA2=CSA**2
      CSB2=CSB**2
      DSA2=DSA**2
      DSB2=DSB**2
      PJ1=YXS(4)*COD-2.*YXS(7)*SID*COD
      PB1=CSA2+CSB2
      PU2=YXS(4)*COD-2.*YXS(8)*SID*COD
      PB2=DSA2+DSB2
      RCRD=SQRT((CSA2+CSB2)/(DSA2+DSB2))
      ACD=ALOG(RCRD)
      SITC=ATAN(CSB/CSA)
      SITD=ATAN(DSB/DSA)
      IF (SITD.LT.0.) SITD=PAI+SITD
      SCD=SITC-SITD
      F(8)=-(COD*ACD+SID*SCD)/PAI-SIN(ALFA1-YXS(5))/COS(YXS(5)+GAMMA)
      P(8,1)=0.
      P(8,2)=0.
      P(8,3)=0.
      P(8,4)=(PJ1/PB1-PU2/PB2)/PAI
      P(8,5)=-COS(ALFA1+GAMMA)/COS(YXS(5)+GAMMA)**2
      P(8,6)=0.
      P(8,7)=YXS(7)*COS(DELTA)/(PAI*(CSA2+CSB2))
      P(8,8)=-YXS(8)*COS(DELTA)/(PAI*(DSA2+DSB2))
```

```
      NCAV1=NCAV+1
      DO 253 ICV=1,NCAV1,2
  253 WRITE(6,252) CAVX(ICV),CAVY(ICV)
  252 FORMAT(10X,*CAVX=*,F10.5,5X,*CAVY=*,F10.5)
      DO 129 ITX=1,8
  129 WRITE(6,131) ITX,P(ITX)
  131 FORMAT(1X,24HP(,I1,2H)=,E14.7)
      DO 132 IUP=1,8
  132 WRITE(6,133)IUP,(P(IJP,JUP),JUP=1,8)
  133 FORMAT(1X,2HP(,I1,4H,J)=,8(E13.6,1X))
  335 CONTINUE
      CALL DETERM(P,8,DETBO)
      DO 25 IDET=1,8
      DO 26 LPG=1,8
      Q(LPG,IDET)=P(LPG,IDET)
   26 P(LPG,IDET)=F(LPG)
      CALL DETERM(P,8,DETE)
      IF(IDET.EQ.1) DELB=DETE/DETBO
      IF(IDET.EQ.2) DELC=DETE/DETBO
      IF(IDET.EQ.3) DELD=DETE/DETBO
      IF(IDET.EQ.4) DELE=DETE/DETBO
      IF(IDET.EQ.5) DELF=DETE/DETBO
      IF(IDET.EQ.6) DELG=DETE/DETBO
      IF(IDET.EQ.7) DELH=DETE/DETBO
      IF(IDET.EQ.8) DELI=DETE/DETBO
      DO 27 LPG=1,8
   27 P(LPG,IDET)=Q(LPG,IDET)
   25 CONTINUE
      X(1)=X(1)+DELB
      X(2)=X(2)+DELC
      X(3)=X(3)+DELD
      X(4)=X(4)+DELE
      X(5)=X(5)+DELF
      X(6)=X(6)+DELG
      X(7)=X(7)+DELH
      X(8)=X(8)+DELI
      DO 60 LMN=1,8
   60 WRITE(6,61) LMN,X(LMN)
   61 FORMAT(1X,24HX(,I1,2H)=,E14.7)
      ABSB=ABS(DELB/X(1))
      ABSC=ABS(DELC/X(2))
      ABSD=ABS(DELD/X(3))
      ABSE=ABS(DELE/X(4))
      ABSF=ABS(DELF/X(5))
      ABSG=ABS(DELG/X(6))
      ABSH=ABS(DELH/X(7))
      ABSI=ABS(DELI/X(8))
      KEIO=0
      IF(ABSB.LT.STOL) KEIO=1
      IF(ABSC.GT.STOL) KEIO=0
      IF(ABSD.GT.STOL) KEIO=0
      IF(ABSE.GT.STOL) KEIO=0
      IF(ABSF.GT.STOL) KEIO=0
      IF(ABSG.GT.STOL) KEIO=0
      IF(ABSH.GT.STOL) KEIO=0
      IF(ABSI.GT.STOL) KEIO=0
      IF(KEIO.EQ.1) GO TO 35
      I=I+1
      WRITE(6,42) I
   42 FORMAT(20X,14HITERATION NO.=,I2)
```

```
      IF(I.EQ.M) GO TO 35
      GO TO 55
   35 IF(I.EQ.M) GO TO 36
      GO TO 38
   36 WRITE(6,37)
   37 FORMAT(1X,34HDX=NEW DID NOT CONVERGE WITHIN TWT)
      IF (X(7).GT.SI7) X(7)=SI7
      IF(X(1).LT.SI1) X(1)=SI1
      SI10=X(1)+2.*DG
      IF(X(2).LT.SI10) X(2)=SI10
      SI11=X(2)+2.*DG
      IF(X(3).LT.SI11) X(3)=SI11
      SI8=X(3)+2.*DELT(3,1)
      IF(X(8).LT.SI8) X(8)=SI8
      IF(X(6).LE.1.E-3) X(6)=1.E-3
      IF(X(4).LT.SI6)  X(4)=SI6
      SI5=(.5*PAI-GAMMA)*(1.-.02)
      IF(X(5).LT.0.) GO TO 31
      IF(X(5).GT.SI5) X(5)=SI5
      GO TO 32
   31 IF(ABS(X(5)).GT.SI5) X(5)=-SI5
   32 CONTINUE
C                                          )2211,6(ETIRW ).0,EL.)7(X( FI
C            )*------------DREZ WAHT SSEL EMACEB )7(X----------*,X2(TAMROF 2211
   38 RETURN
      END

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```
      SUBROUTINE OFSIM1(ANS,NOF,XCA)
      DIMENSION XST(8)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON       SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),     CLE,ERC,YYY,XM,ITERA,SXSIO(8),SXSIOO(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROJNO,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      COMMON/SPC/ESPACE
C     NOF    = 0  CALLED FROM F1INT.
C     NOF    = 1  CALLED FROM RMINT FOR REAL PART.
C     NOF    = 2  CALLED FROM RMINT FOR IMAG. PART.
C     NOF    = 3  CALLED FROM CAVITY OXFNEW AT F(5)
      IF (ICPI.EQ.0) GO TO 9
      DO 10 IQ = 1,8
   10 XST(IQ) = XSN(IQ)
      GO TO 12
    9 DO 11 IH = 1,8
   11 XST(IH) = YXS(IH)
   12 CONTINUE
      IF(ITERA.EQ.1) GO TO 222
      GO TO 223
  222 DO 224 ILK = 1,LPM
  224 BETAN(ILK) = SBETA
  223 CONTINUE
      CSPACE = (1.+XST(1))/FLOAT(LPK)
      FSPACE = CSPACE/FLOAT(LPM-LPK)
      LPM3=LPM-3
      XBET = -1.+CSPACE+FLOAT(LPK-1)
      XSI1=-1.+CSPACE
      BE1 = BETAN(2)
      AP1 = (XSI1-XST(2))/((XSI1+1.)*(XST(1)-XSI1)*(XSI1-XST(3)))
      AP1S = SQRT(AP1)
      F3 = BE1*AP1S
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
      PLM = XSI1 -XX1
      PLM2 = PLM**2
      PLMA = PLM2+YY12
      PXSR = PLM/PLMA
      PXSI = YY1/PLMA
      IF(NOF.EQ.1) F3 = F3*PXSR
      IF(NOF.EQ.2) F3 = F3*PXSI
      IF(NOF.EQ.3) F3=F3/(XSI1-XCA)
      ANSA=0.
      DO 1 I = 2,LPM3,2
      F1 = F3
      SPACE = CSPACE
      IF (I.GE.LPK) GO TO 30
      XSI2 = -1.+SPACE+FLOAT(I)
      XSI3 = XSI2+SPACE
      GO TO 31
   30 SPACE  = FSPACE
```

```
      XSI2 = XBET+SPACE*FLOAT(I-LPK+1)
      XSI3 = XSI2+SPACE
   31 BE2 = BETAN(I+1)
      BE3 = BETAN(I+2)
      AP2 = (XSI2-XST(2))/((XSI2+1.)*(XST(1)-XSI2)*(XSI2-XST(3)))
      AP3 = (XSI3-XST(2))/((XSI3+1.)*(XST(1)-XSI3)*(XSI3-XST(3)))
      AP2S = SQRT(AP2)
      AP3S = SQRT(AP3)
      F2 = BE2*AP2S
      F3 = BE3*AP3S
      HA2 = XSI2-XX1
      HA22 = HA2**2
      HB = HA22+YY12
      HCR2 = HA2/HB
      HCI2 = YY1/HB
      HA3 = XSI3-XX1
      HA32 = HA3**2
      HD=HA32+YY12
      HCR3 = HA3/HD
      HCI3 = YY1/HD
      IF(NOF.EQ.1) F2 = F2*HCR2
      IF(NOF.EQ.1)  F3 = F3*HCR3
      IF (NOF.EQ.2)  F2 = F2*HCI2
      IF(NOF.EQ.2)  F3 = F3*HCI3
      IF (NOF.EQ.3)  F2 = F2/(XSI2-XCA)
      IF(NOF.EQ.3)  F3 = F3/(XSI3-XCA)
      FSUM = (F1+4.*F2+F3)*SPACE/3.
      ANSA = ANSA+FSUM
    1 CONTINUE
      SQ1 = SQRT((-1.-XST(2))/(-1.-XST(3)))
      SQ2 = SQRT(XST(1)+1.)
      SQ3 = SQRT((XST(1)-XST(2))/(XST(1)-XST(3)))
      ANT1 = BETAN(1)*2.*SQRT(CSPACE)*SQ1/SQ2
      ANT2 = BETAN(LPM)*2.*SQRT(FSPACE)*SQ3/SQ2
      APLA = -1.-XX1
      APLA2 = APLA**2
      APLB = XST(1)-XX1
      APLB2 = APLB**2
      IF(NOF.EQ.1) ANT1 = ANT1*APLA/(APLA2+YY12)
      IF (NOF.EQ.2 ) ANT1 = ANT1*YY1/(APLA2+YY12)
      IF (NOF.EQ.1) ANT2 = ANT2*APLB/(APLB2+YY12)
      IF (NOF.EQ.2) ANT2 = ANT2*YY1/(APLB2+YY12)
      IF (NOF.EQ.3) ANT1 = ANT1/(-1.-XCA)
      IF (NOF.EQ.3) ANT2 = ANT2/(XST(1)-XCA)
      ANS  = ANSA+ANT1+ANT2
      RETURN
      END
```

```
      SUBROUTINE DFSIM2(ANS2)
      DIMENSION X(3),XIT(3),YY(3),XITC(3),EXU(3),FCN3(3),XST(8)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSS2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON        SBETA,XKM,ICPI,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),      CLE,ERC,YYY,XM,ITERA,SXSIO(8),SXSIOO(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      COMMON/SPC/ESPACE
      DO 13 I6=1,8
   13 XST(I6)=YXS(I6)
      PAI=3.141592653
      CCC1=ALOG(1.+XST(6))/(2.*PAI)
      UU2=COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)/ESPACE
      XKK=ALOG(UU2)
      CSPACE=(1.+ XST(1))/FLOAT(LPK)
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(LPM-LPK)
      HFSPAC=0.5*FSPACE
      XBET=-1.+CSPACE*FLOAT(LPK-1)
      CDE=COS(DELTA)
      SDE=SIN(DELTA)
      GA=XST(1)-XST(4)*SDE
      GB=XST(4)*CDE
      PPP=CDE/(GA**2+GB**2)
      FCN3(3)=DGAP*PPP*XST(1)/(PAI*SQRT(1.+XST(6)))
      LPKI=LPM-LPK+1
      DO 1 IP=1,LPM
      IF(IP.EQ.1) GO TO 2
      HSPACE=HFSPAC
      SPACE=FSPACE
      IF(IP.GT.LPKI) GO TO 30
      X(1)=XST(1)-SPACE*FLOAT(IP-2)
      X(2)=X(1)-HSPACE
      X(3)=X(1)-SPACE
      GO TO 31
   30 HSPACE=HCSPAC
      SPACE=CSPACE
      X(1)=XBET-SPACE*FLOAT(IP-LPKI-1)
      X(2)=X(1)-HSPACE
      X(3)=X(1)-SPACE
   31 FCN3(1)=FCN3(3)
      NK=3
      IF(IP.EQ.LPM) NK=2
      DO 9 I=2,NK
      IF(IJ.EQ.407) GO TO 7
      IF(IJ.EQ.408) GO TO 7
      IF(IJ.EQ.409) GO TO 7
      IF(IJ.EQ.410) GO TO 7
      IF(IJ.GE.23) GO TO 3
      GO TO 7
    3 IF(I.EQ.2) XIT(2)=XITM(LPM-IP+1)
      IF(I.EQ.3) XIT(3)=XITN(LPM-IP+1)
      GO TO 5
```

```
    7 CONTINUE
      YY(I)=X(I)
C DFSIM3 CALCULATE G1 .
      CALL DFSIM3(YY(I),XITC(I),IP,I)
      XIT(I)=XITC(I)
      IF(IJ.EQ.18) GO TO 6
      GO TO 5
    6 IF(I.EQ.2) XITM(LPM-IP+1)=XIT(I)
      IF(I.EQ.3) XITN(LPM-IP+1)=XIT(I)
    5 CONTINUE
      EXU(I)=EXP(-XIT(I))
      GC=X(I)-XST(4)*SDE
      GD=XST(4)*CDE
      PXA=GC**2+GD**2
      DWDX=DSAP*X(I)*CDE/(PXA*PAI)
      FCN3(I)=EXU(I)*DWDX/JJ2
      IF(X(I).LE.0.) FCN3(I)=-FCN3(I)
    8 CONTINUE
C CHECK IF FCN3(I) IS ALWAYS POSITIVE.
      IF(IP.EQ.LPM) GO TO 20
      GO TO 21
   20 PPQ=CDE/((-1.-XST(4)*SDE)**2+(XST(4)*CDE)**2)
      FF3=DSAP*PPQ/PAI
      FCN3(3)=FF3
   21 SUM=(FCN3(1)+FCN3(2)*4.+FCN3(3))*HSPACE/3.
      ANS2=ANS2+SUM
      IF(IJ.EQ.18) SARC(LPM-IP+1)=ANS2
      GO TO 1
    2 SARC(LPM)=0.
      ANS2=0.
    1 CONTINUE
C XITN(LPM)=G1 AT POINT B.
C XINT(1)=G1 AT POINT X=1.
      XITN(LPM)=CCC1-XKKK/PAI
      XITN(I)=0.
      RETURN
      END

**
```

```
      SUBROUTINE OFSIM3(Y,XXII,IP,I)
      DIMENSION XST(8),FA(200)
      COMMON YCCC,SBETA2
      COMMON XITN(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFAI,GAMMA
      COMMON       SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),     CLE,ERC,YYY,XM,ITERA,SXSID(8),SXSIDD(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XJK
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      COMMON/SPC/ESPACE
      COMMON/TAU1/JTAU
      COMMON/CVTYL/CAVLEN,BIGS2
C     FOUR INTEGRALS TO BE EVALUATED BEFORE XI IS OBTAINED.
C     NOTE THAT PRIVIOUSLY ONLY ONE  SINGULAR INTEGRAL WAS
C     CALCULATED IN GCASCAD AND CASCADE.
C     SEE THE NOTE OF TC 3951 FOR FOUR INTEGRALS, OUT OF WHICH
C     TWO ARE OF SINGULAR TYPE.
      IF(ICPI.EQ.0) GO TO 9
      DO 11 ISI=1,8
   11 XST(ISI)=XSN(ISI)
      GO TO 12
    9 DO 13 JTJ=1,8
   13 XST(JTJ)=YXS(JTJ)
   12 PAI=3.141592653
      CCC1=ALOG(1.+XST(6))/(2.*PAI)
      SSG=SQRT(1.+XST(6))
      U2=COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)/ESPACE
      U22=U2**2
      U22I=1./U22
      TW0=SSG*CAVLEN/U2+(1.-CAVLEN)
      TAUW0=ALOG(TW0)
      TW1=SQRT(1.-(1.-XST(6)-U22I)*CAVLEN)
      TAUW1=ALOG(TW1)
      IF (JTAU.EQ.0) TAUW=TAUW0
      IF (JTAU.EQ.1) TAUW=TAUW1
C-----FIRS  I1-------
      IF (ITERA.EQ.1) GO TO 60
      GO TO 61
   60 CONTINUE
      DO 62 IZU = 1,LPM
      BETAN(IZU) = SBETA
      BETAM(IZU) = SBETA
   62 CONTINUE
   61 CONTINUE
      CSPACE=(1.+ XST(1))/FLOAT(LPK)
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(LPM-LPK)
      HFSPAC=0.5*FSPACE
      XBET=-1.+CSPACE*FLOAT(LP(-1)
      AB2=SQRT(XST(1)+1.)
      AB3=SQRT((1.+Y)*(XST(1)-Y))
      AB6 = SQRT((XST(3)-Y)/(XST(2)-Y))
      AB3 = AB3*AB6
      IJ2=LPM-IP+1
      IJ3=1
```

```
      IF(I.EQ.3) IU3=LPM-IP+1
      IF(I.EQ.0) IU3=IP
      BEC=BETAN(IU3)
      IF(I.EQ.2) BEC=BETAM(IU2)
      FAA=BEC/AB3
      LPM1=LPM-1
      DO 1 IW=2,LPM1
      SPACE=CSPACE
      IF(IW.GT.LPK) GO TO 45
      XSK=-1.+SPACE*FLOAT(IW-1)
      GO TO 46
   45 SPACE=FSPACE
      XSK=XBET+ SPACE*FLOAT(IW-LPK)
   46 IF(I.EQ.2) GO TO 6
      IF(IW.EQ.IU3) GO TO 1
    6 FS=SQRT((1.+XSK)*(XST(1)-XSK))
      FSA1 = SQRT((XST(3)-XSK)/(XST(2)-XSK))
      FS = FS*FSA1
      FA(IW)=(BETAN(IW)/FS-FAA)/(XSK-Y)
    1 CONTINUE
      IF(I.EQ.2) GO TO 30
      XP1=-1.+HCSPAC
      XP2=XP1+CSPACE
      XP4=XST(1)-HFSPAC
      XP3=XP4-FSPACE
      FS1=BETAM(1)/ SQRT((1.+XP1)*(XST(1)-XP1))
      FS2=BETAM(2)/ SQRT((1.+XP2)*(XST(1)-XP2))
      FS3=BETAM(LPM-2)/ SQRT((1.+XP3)*(XST(1)-XP3))
      FS4=BETAM(LPM-1)/ SQRT((1.+XP4)*(XST(1)-XP4))
      FSA1 = SQRT((XST(2)-XP1)/(XST(3)-XP1))
      FSA2 = SQRT((XST(2)-XP2)/(XST(3)-XP2))
      FSA3=SQRT((XST(2)-XP3)/(XST(3)-XP3))
      FSA4=SQRT((XST(2)-XP4)/(XST(3)-XP4))
      FS1=FS1*FSA1
      FS2=FS2*FSA2
      FS3=FS3*FSA3
      FS4=FS4*FSA4
      FP1=(FS1-FAA)/(XP1-Y)
      FP2=(FS2-FAA)/(XP2-Y)
      FP3=(FS3-FAA)/(XP3-Y)
      FP4=(FS4-FAA)/(XP4-Y)
      IF(IU3.EQ.2) GO TO 21
      IF(IU3.EQ.LPM1) GO TO 22
      IF(IU3.EQ.LPK) GO TO 51
      FA(IU3)=0.5*(FA(IU3-1)+FA(IU3+1))
      GO TO 30
   51 BETO=2.*BETAN(LPK)-BETAN(LPK+1)
      XOA=XBET-FSPACE
      FPW=BETO/SQRT((1.+XOA)*(XST(1)-XOA))
      FPWA = SQRT((XST(2)-XOA)/(XST(3)-XOA))
      FPW=FPWA*FPW
      FLPK=(FPW-FAA)/(XOA-Y)
      FA(IU3)=0.5*(FA(IU3+1)+FLPK)
      GO TO 30
   21 FA(IU3)=(FP1+FP2)/2.
      GO TO 30
   22 FA(IU3)=(FP3+FP4)/2.
   30 XI=0.
      LPM3=LPM-3
      SPACE=CSPACE
```

```
      DO 15 JA=2,LPM3,2
      IF(JA.GE.LP4) SPACE=FSPACE
   15 XI=XI+(FA(JA)+4.*FA(JA+1)+FA(JA+2))*SPACE/3.
      IF(I.EQ.2) GO TO 35
      XI23=0.5*HCSPAC*(FP1+FA(2))+(FA(LPM-1)+FP4) *0.5*HFSPAC
      XKI=41.
      KJ=39
      LPMA=LPM-5
      IF(IU3.GE.LPMA) XKI=201.
      IF(IU3.GE.LPMA) KU=199
      BOZ=(BETAM(1)-BETAN(1))/XKI
      BOY=(BETAN(LPM)-BETAN(LPM1))/XKI
      HFF=HFSPAC/XKI
      HFH=HCSPAC/XKI
      FT3=FP1
      FJ3=FP4
      XI4=0.
      XI1=0.
      DO 202 ITM=1,KU,2
      FT1=FT3
      FJ1=FJ3
      XM2=XST(1)-HFSPAC+HFF*FLOAT(ITM)
      XM3=XM2+HFF
      XT2=-1.+HCSPAC-HFH*FLOAT(ITM)
      XT3=XT2-HFH
      BETA2=BETAM(LPM1)+BOY*FLOAT(ITM)
      BETA3=BETA2+BOY
      BETT2=BETAM(1)-BOZ*FLOAT(ITM)
      BETT3=BETT2-BOZ
      FS2=BETA2/SQRT((1.+XM2)*(XST(1)-XM2))
      FS3=BETA3/SQRT((1.+XM3)*(XST(1)-XM3))
      FV2=BETT2/SQRT((1.+XT2)*(XST(1)-XT2))
      FV3=BETT3/SQRT((1.+XT3)*(XST(1)-XT3))
      FS2A = SQRT((XST(2)-XM2)/(XST(3)-XM2))
      FS3A = SQRT((XST(2)-XM3)/(XST(3)-XM3))
      FV2A = SQRT((XST(2)-XT2)/(XST(3)-XT2))
      FV3A = SQRT((XST(2)-XT3)/(XST(3)-XT3))
      FS2 = FS2*FS2A
      FS3 = FS3*FS3A
      FV2 = FV2*FV2A
      FV3 = FV3*FV3A
      FJ2=(FS2-FAA)/(XM2-Y)
      FJ3=(FS3-FAA)/(XM3-Y)
      FT2=(FV2-FAA)/(XT2-Y)
      FT3=(FV3-FAA)/(XT3-Y)
      XI4=XI4+HFF*(FU1+FU2*4.+FU3)/3.
  202 XI1=XI1+HFH*(FT1+FT2*4.+FT3)/3.
      XA4=BETAN(LPM)*2.*SQRT(HFF)/(AB2*(XST(1)-Y))
      XA4A = SQRT((XST(2)-XST(1))/(XST(3)-XST(1)))
      XA4 = XA4*XA4A
      XI4=XI4+XA4
      XA1=BETAN(1)*2.*SQRT(HFH)/(AB2*(-1.-Y))
      XA1A = SQRT((XST(2)+1.)/(XST(3)+1.))
      XA1 = XA1*XA1A
      XI1=XI1+XA1
      XI=(XI+XI23+XI1+XI4)*AB3/PAI
      XI=XI+BEC*ALOG((XST(1)-Y-HFF)/(1.+Y-HFH))/PAI
      XXI1=-XI
      GO TO 36
   35 XR1=-1.+0.5*HCSPAC
```

```
XR2=XR1+HCSPAC
XR4=XST(1)-0.5*HFSPAC
XR3=XR4-HFSPAC
FT1=0.5*(BETAN(1)+BETAM(1))/ SQRT((1.+XR1)*(XST(1)-XR1))
FT2=0.5*(BETAM(1)+BETAN(2))/ SQRT((1.+XR2)*(XST(1)-XR2))
FT3=0.5*(BETAN(LPM-1)+BETAM(LPM-1))/ SQRT((1.+XR3)*(XST(1)-XR3))
FT4=0.5*(BETAM(LPM-1)+BETAN(LPM))/ SQRT((1.+XR4)*(XST(1)-XR4))
FT1A = SQRT((XST(2)-XR1)/(XST(3)-XR1))
FT2A = SQRT((XST(2)-XR2)/(XST(3)-XR2))
FT3A = SQRT((XST(2)-XR3)/(XST(3)-XR3))
FT4A = SQRT((XST(2)-XR4)/(XST(3)-XR4))
FT1 = FT1*FT1A
FT2 = FT2*FT2A
FT3 = FT3*FT3A
FT4 = FT4*FT4A
FR1=(FT1-FAA)/(XR1-Y)
FR2=(FT2-FAA)/(XR2-Y)
FR3=(FT3-FAA)/(XR3-Y)
FR4=(FT4-FAA)/(XR4-Y)
XIP1=0.5*HCSPAC*(FR1+FR2)+0.5*HFSPAC*(FR3+FR4)
XIP2=0.25*HCSPAC*(FR2+FA(2))+0.25*HFSPAC*(FA(LPM-1)+FR3)
XI23=XIP1+XIP2
XMI=21.
XMI2=42.
MJ=21
M2=MU-2
LPMA=LPM-5
IF(IU2.GE.LPMA) XMI=101.
IF(IU2.GE.LPMA) XMI2=202.
IF(IU2.GE.LPMA) MU=101
IF(IU2.GE.LPMA) M2=MJ-2
BETY=(BETAN(LPM)-BETAM(LPM-1))/XMI2
BESS=0.5*(BETAN(LPM)+BETAM(LPM-1))
HSP5=0.5*HFSPAC/XMI
FQ3=FR4
BETY1=(BETAM(1)-BETAN(1))/XMI2
BESS1=0.5*(BETAM(1)+BETAN(1))
HSP51=0.5*HCSPAC/XMI
FQ31=FR1
XI1=0.
XI4=0.
DO 129 IL=1.M2.2
FQ1=FQ3
FQ11=FQ31
X2=XST(1)-HSP5*FLOAT(MU-IL)
X3=X2+HSP5
X21=-1.+HSP51*FLOAT(MU-IL)
X31=X21-HSP51
BETA2=BESS+BETY*FLOAT(IL)
BETA3=BESS+BETY*FLOAT(IL+1)
BETA21=BESS1-BETY1*FLOAT(IL)
BETA31=BETA21-BETY1
FJ21=BETA21/ SQRT((1.+X21)*(XST(1)-X21))
FJ31=BETA31/ SQRT((1.+X31)*(XST(1)-X31))
FJ21A = SQRT((XST(2)-X21)/(XST(3)-X21))
FJ31A = SQRT((XST(2)-X31)/(XST(3)-X31))
FJ21 = FJ21*FJ21A
FJ31 = FJ31*FJ31A
FQ21=(FJ21-FAA)/(X21-Y)
FQ31=(FJ31-FAA)/(X31-Y)
```

```
      FU2=BETA2/ SQRT((1.+X2)*(XST(1)-X2))
      FU3=BETA3/ SQRT((1.+X3)*(XST(1)-X3))
      FU2A = SQRT((XST(2)-X2)/(XST(3)-X2))
      FU3A = SQRT((XST(2)-X3)/(XST(3)-X3))
      FU2 = FU2*FU2A
      FU3 = FU3*FU3A
      FQ2=(FU2-FAA)/(X2-Y)
      FQ3=(FU3-FAA)/(X3-Y)
      XI1=XI1+HSP61*(FQ11+FQ21+4.*FQ31)/3.
  129 XI4=XI4+HSP6*(FQ1+4.*FQ2+FQ3)/3.
      XIA=2.*SQRT(HSP6)*BETAN(LPM)/(AB2*(XST(1)-Y))
      XIAA = SQRT((XST(2)-XST(1))/(XST(3)-XST(1)))
      XIA = XIA*XIAA
      XI4=XI4+XIA
      XIB=2.*SQRT(HSP61)*BETAN(1)/(AB2*(-1.-Y))
      XIBA = SQRT((XST(2)+1)/(XST(3)+1.))
      XIB = XIB*XIBA
      XI1=XI1+XIB
      XI=(XI+XI1+XI23+XI4)*AB3/PAI
      XI=XI+BEC*ALOG((XST(1)-Y-HSP6)/(1.+Y-HSP61))/PAI
      XXI1=-XI
   36 CONTINUE
C-------I2----------
C----------IF Y IS LESS THAN ZERO, THIS IS A
C-----REGULAR INTEGRAL, WHILE Y .GE. 0, THIS IS A
C-----SINGULAR INTEGRAL.
C     BUT THIS IS TREATED AS A SINGULAR INTEGRAL ANYWAY
      ISIC=3
      XCA=Y
      CALL IC2(SR,S4,XCA,ISIC)
      XXI2=SR
      ARGL=(XST(1)      -Y)/Y
      IF (ARGL.LT.0.) ARGL=-ARGL
      XXI2=XXI2+AB3*ALOG(ARGL)
      XXI2=-XXI2
C-----I3---------
C     USE CHEBYSHEV-GAUSS QUADRATURE.
C     AJ(I) ARE ALREADY CALCULATED IN SUBROUTINE F1INTL
C     AND PASSED ONTO HERE BY COMMON STATEMENT.
      XXI3 = 0.
      BPC5 = (XST(1)+XST(2))*.5
      CMB5 = (XST(2)-XST(1))*.5
      A31 = (BPC5+1.)/CMB5
      A32 = (-BPC5+XST(3))/CMB5
      DO 120 ISJM = 1,NCHBY
      HA1 = 1.-AJ(ISJM)
      HA2 = (AJ(ISJM)+A31)*(A32-AJ(ISJM))
      SHA2 = SQRT(HA2)
      F3I3 = HA1/SHA2
      F3AI3 = CMB5*AJ(ISJM)+BPC5-Y
  120 XXI3 = XXI3+F3I3/F3AI3
      XXI3 = XXI3*PAI/NCHBY
      UU22 = COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)/ESPACE
C                            )7(TSX/)AMMAG+)5(TSX(SOC/)AMMAG+1AF_A(SOC = 22UJ
      HX3 = CCC1-ALOG(UU22)/PAI
      XXI3 = XXI3+AB3*HX3
C-----I4---------
C     USE CHEBYSHEV-GAUSS QUADRATURE FORMULA---
C------BBETAN2(I) ARE ALREADY CALCULATED IN
C     SUBROUTINE F1INTL AND PASSED ONTO HERE BY
```

```
C      COMMON STATEMENT.
       FPC5 = (XST(3)+XST(2))*.5
       FMC5 = (XST(3)-XST(2))*.5
       A41 = (FPC5+1.)/FMC5
       A42 = (FPC5-XST(1))/FMC5
       XXI4 = 0.
       DO 130 ISUM = 1,NCHBY
       RAX = (BBTAN2(ISUM)+PAI)*(1.+AJ(ISUM))
       RBX = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
       SRBX = SQRT(RBX)
       RCX = RAX/SRBX
       RDX = FMC5+AJ(ISUM)+FPC5-Y
  130  XXI4 = XXI4 + RCX/RDX
       XXI4 = XXI4+PAI/NCHBY
       XXI4 = -XXI4+AB3/PAI
C-----I5----------
       GP1H=(XST(7)+1.)*.5
       GM1H=(XST(7)-1.)*.5
       A51=(GM1H-XST(2))/(-GP1H)
       A52=(GM1H-XST(1))/(-GP1H)
       A53=(GM1H-XST(3))/(-GP1H)
       XXI5=0.
       DO 70    ISJM=1,NCHBY
       HA1  =-(1.+AJ(ISUM))*(AJ(ISJM)+A51)
       HA2  =(AJ(ISUM)+A52)*(AJ(ISJM)+A53)
       F5A=SQRT(HA1/HA2)
       F5B=(-GP1H+AJ(ISJM)+GM1H)-Y
    70 XXI5=XXI5+F5A/F5B
       XXI5=PAI+XXI5/NCHBY
C-----I6----------
       HMFH=(XST(8)-XST(3))*.5
       HPFH=(XST(8)+XST(3))*.5
       A61=(HPFH-XST(2))/HMFH
       A62=(HPFH+1.)/HMFH
       A63=(HPFH-XST(1))/HMFH
       XXI6=0.
       DO 80    ISJM=1,NCHBY
       HA1  =(1.-AJ(ISUM))*(AJ(ISUM)+A61)
       HA2  =(AJ(ISUM)+A62)*(AJ(ISJM)+A63)
       F6A=SQRT(HA1/HA2)
       F6B=HMFH+AJ(ISUM)+HPFH-Y
    80 XXI6=XXI6+F6A/F6B
       XXI6=PAI+XXI6/NCHBY
       XXII = XXI1+XXI2+XXI3+XXI4+AB3+TAJW*(-XXI5+XXI6)/PAI
       IWRIT1=2
       IWRIT2=30
       IWRIT3=60
       IF (IJ.EQ.18.AND.IP.EQ.IWRIT1) WRITE(6,55) XXI1,XXI2,XXI3 ,XXI4,IP
       IF (IJ.EQ.18.AND.IP.EQ.IWRIT2) WRITE(6,55) XXI1,XXI2,XXI3,XXI4,IP
       IF (IJ.EQ.18.AND.IP.EQ.IWRIT3) WRITE (6,55) XXI1,XXI2,XXI3,XXI4,IP
    55 FORMAT (10X,'----I1,I2,I3,I4 OF F(4) ARE---',4(E14.7,2X),2X,
      A'IP=',I4)
       RETURN
       END


/*
```

```
      SUBROUTINE DFSIM5(ANS5)
      DIMENSION S2SR(101),S2KER(101),XST(9)
      COMMON YCCC,SBETA2
      COMMON XITN(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON       SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDJ_,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),     CLE,ERC,YYY,KM,ITERA,SXSID(8),SXSIDD(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      COMMON/SPC/ESPACE
      PAI=3.141592654
C     THIS SUBROUTINE CALLED FROM DKFNEW.
C     USE SIMPSONTS RULE.
      DO 1 IMO = 1,8
    1 XST(IMO) = YXS(IMO)
      CDE = COS(DELTA)
      SDE = SIN(DELTA)
C  NS2 SHOULD HAVE A FACTOR OF 4.
C NS2=LPMM=LPM2
      NS21 = NS2+1
      NS2A = NS2-1
      S2GAP = (XST(3)-XST(2))/NS2
      JJ2 = COS(A_FA1+GAMMA)/COS(XST(5)+GAMMA)/ESPACE
C                          )7(TSX/)AMMAG+)5(TSX(SDC/)AMMAG+1AFLA(SCC = 2UJ
      DO 2 IS2 = 1,NS21
      XS2 = XST(2)+S2GAP*(IS2-1)
      XKD = XS2*CDE
      XMAS = XS2-XST(4)*SDE
      XMAS2 = XMAS**2
      ASD = XST(4)*CDE
      ASD2 = ASD**2
      DWDX = DGAP*XKD/((XMAS2+ASD2)*PAI)
      IF (IS2.EQ.1) GO TO 3
      IF (IS2.EQ.NS21) GO TO 4
      CALL G2 (XS2,ANSG2,IS2)
C     G2 CALCULATES G2 WITH XSI GIVEN.
      EG2 = EXP(-ANSG2)
      IF(IJ.EQ.40) ANSG2S(IS2)=ANSG2
      S2KER(IS2) = EG2*DWDX/UU2
      GO TO 2
    3 CONTINUE
      S2KER(1) = DWDX/SQRT(1.+XST(6))
      ANSG2S(IS2)=ALOG(SQRT(1.+XST(6))/UU2)
      GO TO 2
    4 CONTINUE
      S2KER(NS21) = DWDX/JJ2
      ANSG2S(IS2)=0.
    2 CONTINUE
      S2SR(1) = 0.
      DO 10 JS2 = 1,NS2A,2
   10 S2SR(JS2+2) = S2SR(JS2)
     1+(S2KER(JS2)+4.*S2KER(JS2+1)+S2KER(JS2+2))*S2GAP/3.
      IF(IJ.NE.40) GO TO 40
      SARC2(1)=0.
      DO 50 ISARC=2,NS2,2
```

```
   30 S2SR(ISARC)=.5*(S2SR(ISARC-1)+S2SR(ISARC+1))
      DO 30 ISARC=1,NS21
   30 SARC2(ISARC)=S2SR(ISARC)
   40 CONTINUE
      ANS5 = S2SR(NS21)
      RETURN
      END
```

```
      SUBROUTINE IC2(SR,SM,XCA,ISIC)
      DIMENSION XST(8)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON       SBETA,KKM,ICPI,SARCDD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),     DLE,ERC,YYY,XM,ITERA,SXSIO(8),SXSIOO(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      COMMON/SPC/ESPACE
      DO 1 IPN = 1,8
    1 XST(IPN) = YXS(IPN)
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
C     ISIC = 0 FOR RMINT
C          = 1 IN CAVITY OF OFSIMS FOR F(5) AND IN CAVITY.
C            2 CALLED FROM FIINTL FOR F(1).
C            3 FOR I2 OF F(4).
      SR=0.
      SM=0.
      BH=XST(1)*.5
      BHMC=BH-XST(2)
      BHP1=BH+1.
      BHMF=BH-XST(3)
      HPFH=(XST(8)+XST(3))*.5
      HMFH=(XST(8)-XST(3))*.5
      GM1H=(XST(7)-1.)*.5
      GP1H=(XST(7)+1.)*.5
      AS1=(GM1H-XST(2))/(-GP1H)
      AS2=(GM1H-XST(1))/(-GP1H)
      AS3=(GM1H-XST(3))/(-GP1H)
      AS1=(HPFH-XST(2))/HMFH
      AS2=(HPFH+1.)/HMFH
      AS3=(HPFH-XST(1))/HMFH
      B11=BHMC/BH
      B12=BHP1/BH
      B13=BHMF/BH
      IF(ISIC.NE.3) GO TO 20
      AP1=(XCA+1.)*(XST(1)-XCA)*(XCA-XST(3))
      AP2=XCA-XST(2)
      APS=SQRT(AP1/AP2)
   20 CONTINUE
      DO 7 ISUM=1,NCHBY
      RA=(AJ(ISJM)+B11) *(AJ(ISJM)+1.)
      RB=(AJ(ISUM)+B12)*(AJ(ISUM)+B13)
      IF (ISIC.EQ.-5) RA=(AJ(ISJM)+1.)*(-AJ(ISUM)-AS1)
      IF (ISIC.EQ.-5) RB=(AJ(ISUM)+AS2)*(AJ(ISUM)+AS3)
      IF (ISIC.EQ.-6) RA=(AJ(ISJM)+AS1)*(-AJ(ISJM)+1.)
      IF (ISIC.EQ.-6) RB=(AJ(ISJM)+AS2)*(AJ(ISUM)+AS3)
      SAB=SQRT(RA/RB)
      SAC=BH*SQRT(1.-AJ(ISJM)**2)/SAB
      XSIP=BH*AJ(ISUM)+BH
      XPXP=XSIP-XX1
      XPXP2=XPXP**2
```

```
      RV2=XP*XP2+YY12
      RWR=XP*XP/RV2
      RWI=YY1/RV2
      IF(ISIC.EQ.1) RWR=1./(XSIP-XCA)
      IF(ISIC.EQ.2) RWR=1.
      IF(ISIC.EQ.3) RWR=(1.-SAC/AP*S)/( XSIP-XCA)
      IF (ISIC.EQ.-5) RWR=1.
      IF (ISIC.EQ.-6) RWR=1.
      SR=SR+SAB*RWR
    7 SM=SM+SAB*RWI
      PAI=3.141592654
      SR=SR*PAI/NCHBY
      SM=SM*PAI/NCHBY
      RETURN
      END
```

```
      SUBROUTINE FIINTL(YINT,XCTRL)
      DIMENSION XST(8)
      COMMON YCCC,SBETA2
      COMMON XITN(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON       SBETA,XXM,ICPI,SARCDD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),     CLE,ERC,YYY,KM,ITERA,SXSID(8),SXSIDD(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      COMMON/SPC/ESPACE
C     SUBROUTINE FIINTL CALCULATES THE INTEGRALS IN F(1)
C     ISHARP = 0 FOR SHARP L.E.FOILS.
C     ISHARP = 1 FOR ROUNDED L.E.FOILS.
C     IF FOILS HAVE ROUNDED L.E.'S CHEBYSHEV-GAUSS
C     QUADRATURE
C     QUADRATURE FORMULA CAN NOT BE USED.  SINCE BETA
C     IS NOT A SMOOTH FUNCTION.
C     NCHBY = NUMBER OF CHEBYSHEV-GAUSS QUADRATURE CONTROL POINTS.
      PAI = 3.141592654
      IF(ICPI.EQ.0) GO TO 9
      DO 70 IQ=1,8
   70 XST(IQ) = XSN(IQ)
      GO TO 12
    9 DO 11 IH = 1,8
   11 XST(IH) = YXS(IH)
   12 CONTINUE
      DN1 = (XST(1)+1.)*.5
      DN2 = (XST(1)-1.)*.5
      A11 = (DN2-XST(2))/DN1
      A12 = (DN2-XST(3))/DN1
      BC5 = (XST(1)+XST(2))*.5
      CMB5=(XST(2)-XST(1))*.5
      A31 = (BC5+1.)/CMB5
      A32 = (-BC5+XST(3))/CMB5
      FCA5 = (XST(3)-XST(2))*.5
      FC15 = (XST(3)+XST(2))*.5
      A41 = (FC15+1.)/FCA5
      A42 = (FC15-XST(1))/FCA5
      SPACE2 = (XST(3)-XST(2))/LPMM
C     READ LPMM FOR THE SECOND ARC.
      IF((XCTRL.GE.2) GO TO 100
      IF(IJ.GE.2) GO TO 100
      CSPACE = (1.+XST(1))/FLOAT(LPK)
      FSPACE = CSPACE/FLOAT(LPM-LPK)
      IDM = 1
      XCHCK = -1.
      SPACE=CSPACE
      DO 20 ICHBY=1,NCHBY
      NCH=NCHBY-ICHBY+1
      AJ(ICHBY)=COS((2*NCH-1)*PAI/(2*NCHBY))
      XXSI=DN1*AJ(ICHBY)+DN2
      IF(ITERA.EQ.1) GO TO 488
   22 IF(XCHCK.GE.XXSI) GO TO 21
      IF(IDM.GE.LPK) SPACE = FSPACE
      XCHCK = XCHCK+SPACE
```

```
      IOM = IOM+1
      GO TO 22
C  XXSI EXISTS BTW XSI(IOM-1) AND XSI(IOM)
   21 CONTINUE
      IOMA = IOM-1
      BBTAN(ICHBY) = BETAN(IOM)+(BETAN(IOM)-BETAN(IOMA))
     X*(XXSI-XCHCK)/SPACE
C     BBTAN IS USED FOR CHEBYCHEV-GAUSS INSTEAD OF BETAN.
      GO TO 20
  488 BBTAN(ICHBY) = SBETA
C BETAN FOR ITERA.EQ.1 IS SPECIFIED IN OFSIM1.
   20 CONTINUE
  100 CONTINUE
      IF (KCTRL.EQ.6) GO TO 6
      IF (KCTRL.EQ.5) GO TO 5
      IF(KCTRL.EQ.4) GO TO 4
      IF (KCTRL.EQ.3) GO TO 3
      IF (KCTRL.EQ.2) GO TO 2
      IF (ISHARP.EQ.1) GO TO 10
      YINT  = 0.
      DO 110 ISUM = 1,NCHBY
      ABC = (AJ(ISUM)+A11)/(AJ(ISUM)+A12)
  110 YINT  = YINT +BBTAN(ISUM)*SQRT(ABC)
      YINT = YINT*PAI/NCHBY
      GO TO 1000
   10 CONTINUE
C  THIS IS THE CASE OF HANDLING RADED L. E. .
      NOF = 0
      XCA = 0.
      CALL OFSIM1(YINT,NOF,XCA)
C     XCA IS DUMMY, ONLY USED FOR F(5) INDXFNEW.
      GO TO 1000
    5 CONTINUE
      ISIC=-5
      XCA=0.
      CALL IC2(SR,SM,XCA,ISIC)
      YINT=SR
      GO TO 1000
    6 CONTINUE
      ISIC=-6
      XCA=0.
      CALL IC2(SR,SM,XCA,ISIC)
      YINT=SR
      GO TO 1000
    2 CONTINUE
      XCA=0.
C XCA IS DUMMY.
      ISIC=2
      CALL IC2(SR,SM,XCA,ISIC)
      YINT=SR
      GO TO 1000
    3 CONTINUE
C-----INTEGRAL FOR I3.
C  AJ(N) IS CALCULATED AND STORED
      YINT = 0.
      DO 120 ISUM = 1,NCHBY
      A31 = 1.-AJ(ISUM)
      A32 = (AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SQA32 = SQRT(A32)
      ABC = A31/SQA32
```

```
  120 YINT = YINT+ABC
      YINT = YINT*PAI/NCHBY
      GO TO 1000
C-----INTEGRAL FOR I4
C     SINCE BETA(N) BTWN TCT AND TFT ARE
C     EXPECTED TO BE ALWAYS SMOOTH, USE GAUSS-
C     CHEBYSHEV QUADRATURE FORMULA.
C     AJ(N) IS ALREADY CALCULATED.
C     IF THIS IS THE FIRST CASE FOR BETAN2,
C     USE A CONSTANT FOR BETAN2.
C     BBTAN2 IS USED FOR CHEVY-GAUSS INSTEAD OF BETAN2.
    4 CONTINUE
      IF(ITERA.GE.2) GO TO 150
      IF(IJ.GE.2) GO TO 181
C  SBETA2 MUST BE READ FOR THE FIRST RUN.
      DO 180 ICHBY = 1,NCHBY
  180 BBTAN2 (ICHBY) = SBETA2
      NS21=NS2+1
      DO 185 IOC=1,NS21
  185 BETAN2(IOC)=SBETA2
      GO TO 181
  150 CONTINUE
      IF(IJ.GE.2) GO TO 181
      IOMM = 1
      XCHCK = XST(2)
      DO 170 ICHBY = 1,NCHBY
      XKSI = FCA5*AJ(ICHBY)+FC15
  152 IF(XCHCK.GE.XKSI) GO TO 151
      XCHCK = XCHCK + SPACE2
      IOMM = IOMM+1
      GO TO 152
  151 CONTINUE
      IOMMA = IOMM-1
      BBTAN2(ICHBY) = BETAN2(IOMM)
     1+(BETAN2(IOMM)-BETAN2(IOMMA))*(XKSI-XCHCK)/SPACE2
      ILM=ICHBY
      XKSI = FCA5*AJ(ILM  )+FC15
      WRITE(6,250) ILM,BBTAN2(ILM),XKSI
  250 FORMAT(15X,*I=*,I3,2X,*BBTAN2=*,E14.7,2X,*XKSI=*,E14.7)
  170 CONTINUE
  181 CONTINUE
      YINT = 0.
      DO 190 ISUM = 1,NCHBY
      AB1 = (BBTAN2(ISUM)+PAI)*(1.+AJ(ISUM))
      AB2 = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
      SQAB2 = SQRT(AB2)
  190 YINT = YINT + AB1/SQAB2
      YINT = YINT*PAI/NCHBY
 1000 CONTINUE
      RETURN
      END


**
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```
      SUBROUTINE G2 (XS2,AG2,IS2)
      DIMENSION    XST(8),XI21S(200),XI22S(200),XI23S(200),XI24S(200)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETA3,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHAR2,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFAI,GAMMA
      COMMON       SBETA,XXM,ICPI,SARCOJ(513)
      COMMON IDJ1,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),     CLE,ERC,YYY,XM,IFERA,SXSIJ(8),SXSIJO(8),YXS(8)
      COMMON PSIZ,LP,SARCJ(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XJX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      COMMON/SPC/ESPACE
      COMMON/TAJ1/JTAJ
      COMMON/CVTYL/CAVLEN,BIGS2
C     THIS SUBROUTINE IS CALLED BY OFSIM5.
C     THIS SUBROUTINE CALCULATES FUNCTION G2(XS2) WHICH
C     INCLUDES I21(XS2) TO I24(XS2).
C     XS2 IS XSI= AG2 IS THE SOLUTION OF INTEGRALS.
      DO 1 IQP=1,8
    1 XST(IQP)=YXS(IQP)
      PAI = 3.141592654
      CCC1=ALOG(1.+XST(6))/(2.*PAI)
      SSG=SQRT(1.+XST(6))
      U2=COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)/ESPACE
      U22=U2**2
      U22I=1./U22
      TW0=SSG*CAVLEN/U2*(1.-CAVLEN)
      TAUW0=ALOG(TW0)
      TW1=SQRT(1.-(1.-XST(6)-U22I)*CAVLEN)
      TAUW1=ALOG(TW1)
      IF (JTAU.EQ.0) TAUW=TAUW0
      IF (JTAJ.EQ.1) TAUW=TAUW1
      IF (IJ.GE.47) GO TO 100
C---I21(XSI)----.
C     THE SAME INTEGRATION AS THAT IN
C     SUBROUTINE CAVITY FOR GC(XSI)
      NDF = 3
      CALL OFSIM1(ANS,NDF,XS2)
      XI21 = ANS
      IF(IJ.EQ.40) XI21S(IS2) = XI21
C----I22(XSI)----.
C     USE THE SAME SUBROUTINE IC2 AS
C     USED IN CAVITY WITH ISIC=1.
      ISIC=1
      CALL IC2(SR,SM,XS2,ISIC)
      XI22 = SR
C     NOTE THAT SM IS DUMMY VARIABLE.
      IF(IJ.EQ.40) XI22S(IS2) = XI22
C----I23(XSI)----.
C     USE CHEBYCHEV-GAUSS QUADRATURE FORMULA
C       IN EXACTLY SIMILAR MANNER TO THAT IN
C        OFSIM3 FOR I3.
      XI23 = 0.
      BPC5 = (XST(1)+XST(2))*.5
      CMB5 = (XST(2)-XST(1))*.5
      A31 = (BPC5 + 1.)/C435
      A32 = (-BPC5 + XST(3))/CMB5
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      DO 2 ISUM = 1,NCHBY
      HA1 = 1.-AJ(ISUM)
      HA2 = (AJ(ISUM) + A31)*(A32-AJ(ISUM))
      SHA2 = SQRT(HA2)
      F3I3 = HA1/SHA2
      F3AI3 = CMB5*AJ(ISUM)+BPC5-XS2
    2 XI23 = XI23+F3I3/F3AI3
      XI23 = XI23*PAI/NCHBY
      IF (IJ.EQ.40) XI23S(IS2) = XI23
C-----I24-----.
C     USE CHEBYCHEV-GAUSS QUADRATURE
C        FORMULA BY ASSUMING THAT
C        THE KERNEL FCN. IS SMOOTH.
      HU = (XS2+1.)*(XS2-XST(1))*(XST(3)-XS2)
      HV = XS2-XST(2)
      HW = SQRT(HU/HV)
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      XI24 = 0.
      DO 10 ISUM = 1, NCHBY
      TPA1 = AJ(ISUM)+A41
      TPA2 = AJ(ISUM)+A42
      STP = SQRT(TPA1*TPA2)
      F4T = (BBTAN2(ISUM)+PAI)*(1.+AJ(ISUM))/STP
C     BBTAN2 IS CHEBY-GAUSS VERSION FOR BETA ON THE SECOND ARC.
      F4A = FMC5*AJ(ISUM)+FPC5-XS2
      ST2 = SQRT(1.-AJ(ISUM)**2)
      F4B = FMC5 *ST2*(BETAN2(IS2 )+PAI)/HW
   10 XI24 = XI24+(F4T-F4B)/F4A
      XI241 = XI24*PAI/NCHBY
C     BETAN2 IS USED FOR SIMPSONTS RULE.
      XLG = ALOG((XST(3)-XS2)/(XS2-XST(2)))
C     IS2 IS TRANSFERRED THROUGH B2-ARGUMENT.
      XI242 = XLG*(BETAN2(IS2)+PAI)/HW
      XI24 = XI241+XI242
      IF(IJ.EQ.40) XI24S(IS2) = XI24
      GO TO 101
  100 XI21 = XI21S(IS2)
      XI22 = XI22S(IS2)
      XI23 = XI23S(IS2)
      XI24 = XI24S(IS2)
  101 XS2A = -XI21/PAI-XI22
      XS2B=CCC1-ALOG(COS(A_FA1+GAMMA)/COS(XST(5)+GAMMA)/ESPACE)/PAI
C          IAP/))7(TSX/)AMMAG+)5(TSX(SOC/)AMMAG+1AF_A(SOC(GOLA-1CCC = B2SX
      XS2C = XS2B*XI23
      XS2D = -XI24/PAI
      AG2 = (XS2A+XS2C+XS2D)*HW
C---I25-------------
      GP1H=(XST(7)+1.)*.5
      GM1H=(XST(7)-1.)*.5
      A51=(GM1H-XST(2))/(-GP1H)
      A52=(GM1H-XST(1))/(-GP1H)
      A53=(GM1H-XST(3))/(-GP1H)
      XS2E=0.
      DO 20    ISUM=1,NCHBY
      HA1  =-(1.+AJ(ISUM))*(AJ(ISUM)+A51)
      HA2  =(AJ(ISUM)+A52)*(AJ(ISUM)+A53)
      SH12=SQRT(HA1/HA2)
```

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      HA3=-GP1H*AJ(ISUM)+SH1H-XS2
      F5=SH12/HA3
   20 XS2E=XS2E+F5
      XS2E=PAI*XS2E/NCHBY
C---I25-------------
      HMFH=(XST(8)-XST(3))*.5
      HPFH=(XST(8)+XST(3))*.5
      A61=(HPFH-XST(2))/HMFH
      A62=(HPFH+1.)/HMFH
      A63=(HPFH-XST(1))/HMFH
      XS2F=0.
      DO 30    ISJM=1,NCHBY
      HA1  =(1.-AJ(ISUM))*(AJ(ISUM)+A61)
      HA2  =(AJ(ISJM)+A62)*(AJ(ISJM)+A63)
      SH12=SQRT(HA1/HA2)
      HA3=HMFH*AJ(ISUM)+HPFH-XS2
      F6=SH12/HA3
   30 XS2F=XS2F+F6
      XS2F=PAI*XS2F/NCHBY
      AG2=AG2+(-XS2E+XS2F)*TAUW*HW/PAI
      IF (IJ.EQ.27.AND.IS2.EQ.2) WRITE(6,52) XI21,XI22,XI23,XI24,IS2
      IF (IJ.EQ.27.AND.IS2.EQ.10) WRITE(6,52) XI21,XI22,XI23,XI24,IS2
      IF (IJ.EQ.27.AND.IS2.EQ.30) WRITE(6,52) XI21,XI22,XI23,XI24,IS2
   52 FORMAT(10X,'---I1,I2,I3,I4 OF F(5) ARE---',4(E14.7,2X),2X,
     A 'IS2=',I4)
      RETURN
      END

vv
```

```
      SUBROUTINE CAVITY (XCC,YCC)
C THIS SUBROUTINE IS CALLED FROM DXFNEW FOR F(5).
      DIMENSION CKEX(100),SKEY(100),ANSI1(100),SRI2(100),SIC3I3(100)
      DIMENSION SIC4I4(100),XST(8)
      DIMENSION CAVXX(100),CAVYY(100)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHAR2,VCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFA1,GAMMA
      COMMON       SBETA,XKM,ICPI,SARCOD(513)
      COMMON IDJ,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),     CLE,ERC,YYY,XM,ITERA,SXSIO(8),SXSIOO(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XRDJVD,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      COMMON/SPC/ESPACE
      COMMON/TAU1/UTAU
      COMMON/CVTYL/CAVLEN,BIBS2
C XCCC IS THE CAVITY END POINT CALCULATED IN SUB. CAVITY.
      CDEL = COS(DELTA)
      SDEL = SIN(DELTA)
      PAI = 3.141592654
      DO 1 LOA=1,8
    1 XST(LOA) = YXS(LOA)
      SCGM = SQRT(1.+XST(6))
      CCC1=ALOG(1.+XST(6))/(2.*PAI)
      SSG=SQRT(1.+XST(6))
      U2=COS(A_FA1+GAMMA)/COS(XST(5)+GAMMA)/ESPACE
      U22=U2**2
      U22I=1./U22
      TW0=SSG+CAVLEN/U2*(1.-CAVLEN)
      TAUW0=ALOG(TW0)
      TW1=SQRT(1.-(1.-XST(6)-U22I)*CAVLEN)
      TAUW1=ALOG(TW1)
      IF (UTAU.EQ.0) TAUW=TAUW0
      IF (UTAU.EQ.1) TAUW=TAUW1
      NCAV=80
      NCAV1=NCAV+1
      CAVS = (XST(2)-XST(1))/NCAV
C     LEAVE THE LAST POINT OF XSI = C SINCE THERE IS A
C        SINGULARITY FOR SINGLE SPIRAL VORTEX MODEL.
      DO 2 KLM = 1,NCAV1
      XCA = XST(1) +CAVS* (KLM-1)
C     REAL PART OF OMEGA = BETA* PAI.
      IF (KLM.EQ.1) GO TO 3
      IF(KLM.EQ.NCAV1) GO TO 10
C-----IC1(XSI) CALCULATION, CALLING DFSIM1.
      IF (IJ.GE.34) GO TO 75
      NDF = 3
      CALL DFSIM1(ANS,NDF,XCA)
C     ANS IS A SOLUTION FOR IC1(XCI), XCI IS IDENTICAL TO XCA.
      IF (IJ.EQ.27) ANSI1(KLM) = ANS
      GO TO 76
   75 ANS = ANSI1(KLM)
   76 CONTINUE
C---- IC2(XSI) CALCULATION.
      IF(IJ.GE.34) GO TO 77
      ISIC = 1
```

```
      CALL IC2(SR,SM,XCA,ISIC)
C     ONLY SR IS UTILIZED-- SM IS FOR RMINT.
      IF (IJ.EQ.27) SRI2(KLM) = SR
      GO TO 78
   77 SR = SRI2(KLM)
   78 CONTINUE
C-----IC3 (XSI) CALCULATION-- USE CHEBYSHEV-GAUSS
C     QUADRATURE FORMULA.
      BPC5 = (XST(1)+XST(2))*.5
      CMB5 = (XST(2)-XST(1))*.5
      A31 = (BPC5+1.)/CMB5
      A32 = (-BPC5+XST(3))/CMB5
      EK1 = XCA-XST(2)
      EK2 = (XCA+1.)*(XCA-XST(1))*(XCA-XST(3))
      EK3 = SQRT(EK1/EK2)
      EF3B = CMB5*EK3
      IF (IJ.GE.34) GO TO 80
      SIC3 = 0.
      DO 5 ISUM = 1,NCHBY
      EJ1=(AJ(ISJM)+A31)*(A32-AJ(ISJM))
      SEJ1 = SQRT(EJ1)
      EF3 = (1.-AJ(ISUM))/SEJ1
      EF3A = CMB5*AJ(ISUM)+BPC5-XCA
    5 SIC3 = SIC3+(EF3-EF3B*SQRT(1.-AJ(ISJM)**2))/EF3A
      SIC3 = SIC3*PAI/NCHBY
      SIC3 = SIC3+ALOG((XST(2)-XCA)/(XCA-XST(1)))*EK3
      IF(IJ.EQ.27) SIC3I3(KLM) = SIC3
      GO TO 81
   80 SIC3 = SIC3I3(KLM)
   81 CONTINUE
C-----IC4(XSI)-----.
C     USE CHEBYSHEV-GAUSS QUADRATURE FORMULA
C        IN THE SAME MANNER AS THAT FOR I4 IN
C        DFSIM3.
      IF(IJ.GE.34) GO TO 82
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      SIC4 = 0.
      DO 7 ISJM= 1,NCHBY
      RA = (BBTAN2(ISUM)+PAI)*(1.+AJ(ISJM))
      RB = (AJ(ISJM)+A41)*(AJ(ISJM)+A42)
      SRB = SQRT(RB)
      RC = RA/SRB
      RD = FMC5*AJ(ISJM)+FPC5-XCA
    7 SIC4 = SIC4+RC/RD
      SIC4 = SIC4*PAI/NCHBY
      IF(IJ.EQ.27) SIC4I4(KLM)= SIC4
      GO TO 83
   82 SIC4 = SIC4I4(KLM)
   83 CONTINUE
      IF (IJ.EQ.27.AND.KL4.EQ.2) WRITE(6,55) ANS,SR,SIC3,SIC4,KLM
      IF (IJ.EQ.27.AND.KL4.EQ.40) WRITE(6,55) ANS,SR,SIC3,SIC4,KLM
      IF (IJ.EQ.27.AND.KL4.EQ.80) WRITE(6,55) ANS,SR,SIC3,SIC4,KLM
   55 FORMAT (1X,'----I1,I2,I3,I4 OF CAVITY ARE----',4(E14.7,2X),2X,
     A'KLM=',I4)
C  IC(XSI) = 1/EK3  ALREADY CALCULATED.
      UU2 = COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)/ESPACE
C-----I5--------------
```

```
      GP1H=(XST(7)+1.)**.5
      GM1H=(XST(7)-1.)**.5
      A51=(GM1H-XST(2))/(-GP1H)
      A52=(GM1H-XST(1))/(-GP1H)
      A53=(GM1H-XST(3))/(-GP1H)
      SIC5=0.
      DO 30    ISJM=1,NCHBY
      RA    =-(1.+AJ(ISUM))*(AJ(ISUM)+A51)
      RB    =(AJ(ISUM)+A52)*(AJ(ISJM)+A53)
      SRAB=SQRT(RA/RB)
      RC=-GP1H*AJ(ISUM)+GM1H-XCA
      F5=SRAB/RC
   30 SIC5=SIC5+F5
      SIC5=PAI*SIC5/NCHBY
C ----IC6---------
      HMFH=(XST(3)-XST(3))**.5
      HPFH=(XST(3)+XST(3))**.5
      A61=(HPFH-XST(2))/HMFH
      A62=(HPFH+1.)/HMFH
      A63=(HPFH-XST(1))/HMFH
      SIC6=0.
      DO 40    ISUM=1,NCHBY
      RA    =(1.-AJ(ISUM))*(AJ(ISUM)+A61)
      RB    =(AJ(ISJM)+A62)*(AJ(ISJM)+A63)
      SRAB=SQRT(RA/RB)
      RC=HMFH*AJ(ISJM)+HPFH-XCA
      F6=SRAB/RC
   40 SIC6=SIC6+F6
      SIC6=PAI*SIC6/NCHBY
      GC = (-ANS/PAI-SR+(CCC1-ALOG(UU2)/PAI)*SIC3
     1-SIC4/PAI)/EK3
      GC=GC+TAUW*(-SIC5+SIC6)/PAI/EK3
      GO TO 25
    3 GC = BETAB+PAI
      GO TO 25
   10 GC=BETAC+PAI
C BETAB AND BETAC( BODY ANGLES AT B AND C) MUST BE SPEICIEED IN COMMON.
   25 CONTINUE
      XXS = XCA*CDEL
      YYT = XCA-XST(4)*SDEL
      YYT2 = YYT**2
      XXJ = XST(4)*CDEL
      XXJ2 = XXJ**2
      XYB = YYT2+XXJ2
      DWDK = DGAP*XXS/(XYB*PAI)
      CGC = COS(GC)
      SGC = SIN(GC)
      CFC = DWDX/SCGM
      CKEX(KLM) = CGC*CFC
      SKEY (KLM) = SGC*CFC
    2 CONTINUE
      CAVXX(1)=0.
      CAVYY(1)=0.
      DO 15 ICAV=3,NCAV1,2
      CAVXX(ICAV) = CAVXX(ICAV-2)+CAVS*(CKEX(ICAV-2)+4.*
     1CKEX(ICAV-1)+CKEX(ICAV))/3.
   15 CAVYY(ICAV) = CAVYY(ICAV-2)
     1+CAVS*(SKEY(ICAV-2)+4.*SKEY(ICAV-1)+SKEY(ICAV))/3.
      IF(IJ.EQ.27) GO TO 100
      GO TO 101
```

```
      DO 102 ICAV=1,NCAV1,2
      CAVX(ICAV)=CAVXX(ICAV)
  102 CAVY(ICAV)=CAVYY(ICAV)
      XCCC=CAVX(NCAV1)
      YCCC=CAVY(NCAV1)
  101 CONTINUE
      XCC=CAVXX(NCAV1)
      YCC=CAVYY(NCAV1)
      RETURN
      END
```

```
      SUBROUTINE RMINT (SR,SM,MIQ)
      DIMENSION XST(8)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSQ2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON       SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,KLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),     CLE,ERC,YYY,XM,ITERA,SXSIO(8),SXSIOO(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XRDJND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      COMMON/SPC/ESPACE
      PAI = 3.141592654
      IF (ICPI.EQ.0) GO TO 10
      DO 12 I5 = 1,8
   12 XST(I5) = XSN(I5)
      GO TO 11
   10 DO 1 IS = 1,8
    1 XST(IS) = YXS(IS)
   11 CONTINUE
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
      CB5 = (XST(2)-XST(1))*.5
      BC5 = (XST(1)+XST(2))*.5
      A31 = (BC5+1.)/CB5
      A32 = (-BC5+XST(3))/CB5
      BM15 = (XST(1)-1.)*.5
      BP15 = (XST(1)+1.)*.5
      A11 = (BM15-XST(2))/BP15
      A12 = (BM15-XST(3))/BP15
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      GP1H=(XST(7)+1.)*.5
      GM1H=(XST(7)-1.)*.5
      HMFH=(XST(8)-XST(3))*.5
      HPFH=(XST(8)+XST(3))*.5
      A51=(GM1H-XST(2))/(-GP1H)
      A52=(GM1H-XST(1))/(-GP1H)
      A53=(GM1H-XST(3))/(-GP1H)
      A61=(HPFH-XST(2))/HMFH
      A62=(HPFH+1.)/HMFH
      A63=(HPFH-XST(1))/HMFH
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      IF (MIQ.EQ.6) GO TO 6
      IF (MIQ.EQ.5) GO TO 5
      IF(MIQ.EQ.4) GO TO 4
      IF (MIQ.EQ.3) GO TO 3
      IF (MIQ.EQ.2) GO TO 2
C     AJ(I) ARE ALREADY CALCULATED IN SUBROUTINE
C          TFINTL AND STORED IN COMMON AREA.
      SR=0.
      SM=0.
      DO 20 ISUM = 1,NCHBY
      GX1 = 1.-AJ(ISUM)
      GY1 = (AJ(ISUM)+A31)*(A32-AJ(ISUM))
```

```
      SGY1 = SQRT(GY1)
      FF3 = GX1/SGY1
      FX1 = CBS*AJ(ISJM)+BCS
      FX2 = FX1-XX1
      FX22=FX2**2
      FX3 = FX22+YY12
      FF31 = FX2/FX3
      FF32 = YY1/FX3
      SR = SR+FF3*FF31
   20 SM = SM+FF3*FF32
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
    5 CONTINUE
      SR=0.
      SM=0.
      DO 60    ISJM=1,NCHBY
      GX1  =-(1.+AJ(ISUM))*(AJ(ISJM)+A51)
      GX2  =(AJ(ISUM)+A52)*(AJ(ISJM)+A53)
      FF3=SQRT(GX1/GX2)
      XSP=-SP1M*AJ(ISUM)+SM1M
      XPX1=XSP-XX1
      XPX12=XPX1**2
      BOT2=XPX12+YY12
      FF31=XPX1/BOT2
      FF32=YY1/BOT2
      SR=SR+FF3*FF31
   60 SM=SM+FF3*FF32
      SR=SR*PAI/NCHBY
      SM=SM*PAI/NCHBY
      GO TO 1000
    6 CONTINUE
      SR=0.
      SM=0.
      DO 70    ISJM=1,NCHBY
      GX1  =(1.-AJ(ISJM))*(AJ(ISJM)+A61)
      GX2  =(AJ(ISUM)+A62)*(AJ(ISJM)+A63)
      FF3=SQRT(GX1/GX2)
      XSP=SMSM*AJ(ISUM)+SPSM
      XPX1=XSP-XX1
      XPX12=XPX1**2
      BOT2=XPX12+YY12
      FF31=XPX1/BOT2
      FF32=YY1/BOT2
      SR=SR+FF3*FF31
   70 SM=SM+FF3*FF32
      SR=SR*PAI/NCHBY
      SM=SM*PAI/NCHBY
      GO TO 1000
    2 CONTINUE
      IF (ISHARP.EQ.1) GO TO 100
C     ISHARP = 1 MEANS THAT THE FOIL HAS ROUNDED L.E.
C     SO THAT THE SIMPSONYS RULE IS USED.
C     ISHARP = 0 MEANS THAT THE FOIL HAS SHARP L.E.
C     SO THAT CHEBYSHEV GAUSS FORMULA CAN BE USED AS BELOW.
      SR = 0
      SM = 0
      DO 30 ISUM = 1,NCHBY
      ST11 = AJ(ISUM)+A11
      ST12 = AJ(ISUM)+A12
```

```
      FK1 = BBTAN(ISUM)*SQRT(ST11/ST12)
      UN1 = BP15*AJ(ISUM)+B915-XX1
      UN12 = UN1**2
      UN13 = UN12+YY12
      FK11 = UN1/UN13
      FK12 = YY1/UN13
      SR = SR+FK1*FK11
   50 SM = SM+FK1*FK12
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
  100 CONTINUE
C     THIS IS THE CASE THAT THE FOIL HAS ROUNDED L.E.
      NDF = 1
      XCA = 0.
      CALL DFSIM1(SR,NDF,XCA)
C  XCA IS DUMMY----ONLY USED FOR F(5) IN DXFNEW.
      NDF=2
      CALL DFSIM1(SM,NDF,XCA)
      GO TO 1000
    3 CONTINUE
C     USE CHEBYSHEV-GAUSS FORMULA SINCE BETA
C     IN THIS REGION IS SMOOTH.
C     BBTAN2 (ISUM) ARE ALREADY CALCULATED AT TFINTL.
      SR = 0.
      SM = 0.
      DO 50 ISUM = 1,NCHBY
      PSL = (BBTAN2(ISUM)+PAI)*(1.+AJ(ISUM))
      PSM = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
      SQPSM = SQRT(PSM)
      FF4 = PSL/SQPSM
      PSN = FMC5*AJ(ISUM)+FPC5-XX1
      PSN2 = PSN**2
      FF41 = PSN/(PSN2+YY12)
      FF42 = YY1/(PSN2+YY12)
      SR = SR+FF4*FF41
      SM =SM+FF4*FF42
   50 CONTINUE
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
    4 CONTINUE
C     XCA IS DUMMY, ONLY USED FOR IC2 IN F(5)
      XCA = 0.
      ISIC = 0
C     SUBROUTINE IC2 IS ALSO USED IN F(5).
      CALL IC2(SR,SM,XCA,ISIC)
 1000 RETURN
      END

$$
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AD-A081 832 TETRA TECH INC PASADENA CA F/G 9/2
COMPUTER PROGRAMS FOR CALCULATING PARTIALLY CAVITATING BLUNT TR--ETC(U)
JAN 80 S MAEKAWA, O FURUYA N00014-79-C-0234
UNCLASSIFIED TETRAT-TC-3284-02 NL

3 OF 3
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A081 832

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      SUBROUTINE SHAPE(X,Y,BETA,IS1I2)
      COMMON/FREECAV/XFREEC,YFREEC
      COMMON/UPPER/A2AAJ,B2BBJ,C2CCJ,AAAAJ,BBBBJ,CCCCJ,A8J,B8J,C8J,D8J
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON       SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),     CLE,ERC,YYY,XM,ITERA,SXSIO(8),SXSIOO(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROJND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,BB,C8,D8,TGAJS(100),DGAJS(100),NGAUS
      COMMON/SPC/ESPACE
      PAI =3.141592653
      X2=X**2
      X3=X**3
      XS=SQRT(X)
      XH=X*XS
      XFREE2=XFREEC**2
      XFREE3=XFREEC**3
      XFREES=SQRT(XFREEC)
      XFREEH=XFREEC*XFREES
      X22=.2**2
      X23=.2**3
      X2S=SQRT(.2)
      X2H=.2*X2S
      X82=.8**2
      X83=.8**3
      X8S=SQRT(.8)
      X8H=X8S*.8

C WE MUST CHECK TO SEE IF WE ARE GOING TO CALCUATE THE TOP PART
C OR THE BOTTOM PART. IF TOP WE TRANSFER TO 2ND HALF OF ROUTINE.
C IS1I2 = 3 IS USED FOR CALCULATIONS OF UPPER FOIL PROFILE

      IF(IS1I2.EQ.1) GO TO 30
      IF (IS1I2.EQ.3) GO TO 30

      IF (X.LE..2) GO TO 15
      IF (X.LE..8) GO TO 20
      IF (X.GT..8) GO TO 25

   15 Y=A2AA*X+B2BB*X2+C2CC*X3
      YDX=A2AA+B2BB*2.*X+C2CC*3.*X2
      BETA=ATAN(YDX)
      GO TO 60
   20 Y=AAAA*(4./3.*X+8./3.*XH-4.*X2)+BBBB*X+CCCC*XS
      YDX=AAAA*(4./3.+8./3.*1.5*XS-8.*X)+BBBB+.5*CCCC/XS
      BETA=ATAN(YDX)
      GO TO 60
   25 Y=A8+B8*X+C8*X2+D8*X3
      YDX=B8+2.*C8*X+3.*D8*X2
      BETA=ATAN(YDX)
      GO TO 60

C THIS 2ND HALF  OF THE ROUTINE IS FOR CALCULATING THE UPPER HALF
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```
   30 IF (IS1I2.EQ.3) GO TO 70
      IF (XFREEC.LE..2) GO TO 35
      IF (XFREEC.LE..8) GO TO 50
      IF (XFREEC.GT..8) GO TO 55
   70 CONTINUE
      IF (X.LE..2) GO TO 35
      IF (X.LE..8) GO TO 50
      IF (X.GT..8) GO TO 55

   35 IF (IS1I2.EQ.3) GO TO 80
      R1=YFREEC-A2AAU*XFREEC-B2BBJ*XFREE2-C2CCU*XFREE3
      GO TO 81
   80 R1=0.
   81 CONTINUE
      IF (X.GT..2) GO TO 40
      Y=A2AAU*X+B2BBU*X2+C2CCJ*X3+R1
      YOX=A2AAU+2.*B2BBU*X+3.*C2CCU*X2
      BETA=ATAN(YOX)-PAI
      GO TO 60
   40 Y2=A2AAU*.2+B2BBU*X22+C2CCU*X23+R1
      R2=Y2-AAAAJ*(4./3.*.2+8./3.*X2H-4.*X22)-BBBBU*.2-CCCCU*X2S
      IF (IS1I2.EQ.3) R2=0.
      IF(X.GT..8) GO TO 45
      Y=AAAAU*(4./3.*X+8./3.*XH-4.*X2)+BBBBU*X+CCCCU*XS+R2
      YOX=AAAAU*(4./3.+8./3.*1.5*XS-8.*X)+BBBBU+.5*CCCCU/XS
      BETA=ATAN(YOX)-PAI
      GO TO 60
   45 Y3=A8J+B8J*.8+C8U*X82+D8U*X83+R2
      R3=Y3-A8U-B8U*.8-C8U*X82-D8J*X83
      IF (IS1I2.EQ.3) R3=0.
   46 Y=A8U+B8U*X+C8U*X2+D8U*X3+R3
      YOX=B8J+2.*C8J*X+3.*D8J*X2
      BETA =ATAN(YOX)-PAI
      GO TO 60
   50 IF (IS1I2.EQ.3) GO TO 90
      R2=YFREEC-AAAAU*(4./3.*XFREEC+8./3.*XFREEH-4.*XFREES)-BBBBU*XFREEC
     1 -CCCCJ*XFREES
      GO TO 91
   90 R2=0.
   91 CONTINUE
      IF (X.GT..8) GO TO 45
      Y=AAAAJ*(4./3.*X+8./3.*XH-4.*X2)+BBBBU*X+CCCCJ*XS+R2
      YOX=AAAAU*(4./3.+8./3.*1.5*XS-8.*X)+BBBBU+.5*CCCCU/XS
      BETA=ATAN(YOX)-PAI
      GO TO 60
   55 IF (IS1I2.EQ.3) GO TO 100
      R3=YFREEC-A8J-B8J*XFREEC-C8J*XFREE2-D8J*XFREE3
      GO TO 101
  100 R3=0.
  101 CONTINUE
      GO TO 46

   60 RETURN
      END

**
```

```
      SUBROUTINE XCYC(XCB,YCB,CX,CY)
      COMMON/UPPER/A2AAU,B2BBU,C2CCJ,AAAAJ,BBBBU,CCCCJ,A8J,B8U,C8U,D8U
      X(=CX
      XK2=XK**2
      X(3=X(**3
      XKS=SQRT(XK)
      X(H=X(*XKS
      IP=0
      IF (CX.LE..2) GO TO 3
      IF (CX.LE..8) GO TO 4
      IF (CX.GT..8) GO TO 5
    3 F1=A2AAU*X(+B2BBJ*X(2+C2CCJ*X(3
      F2=A2AAU+2.*B2BBU*XK+3.*C2CCU*XK2
      F3=XK-CX
      FXK=F1+(F3/F2-CY)
      D1=F2
      D2=(D1+F3*(2.*B2BBU+6.*C2CCJ*XK))/D1**2
      DFXK=D1+D2
      DIV=FXK/DFX(
      XK=XK-DIV
      IP=IP+1
      Z=ABS(DIV/X()
      IF((Z.LE..000001).OR.(IP.EQ.20)) GO TO 6
      GO TO 3
    4 F1=AAAAU*(4./3.*XK+8./3.*XK(-4.*XK2)+BBBBU*XK+CCCCU*XKS
      F2=AAAAU*(4./3.+8./3.*1.5*X(S-8.*XK)+BBBBU+CCCCJ*.5/XKS
      F3=XK-CX
      FX(=F1+(F3/F2-CY)
      D1=F2
      D2=(D1-F3*(AAAAJ*(8./3.*1.5*.5/XKS-3.)-CCCCJ*.5*.5/XKH))/D1**2
      DFX(=D1+D2
      DIV=FXK/DFXK
      IP=IP+1
      Z=ABS(DIV/XK)
      IF((Z.LE..000001).OR.(IP.EQ.20)) GO TO 6
      GO TO 4
    5 F1=A8J+B8J*XK+C8U*X(2+D8U*X(3
      F2=38J+2.*C8U*XK+3.*D8J*XK2
      F3=XK-CX
      FXK=F1+(F3/F2-CY)
      D1=F2
      D2=(D1-F3*(2.*C8U+6.*D8U*X()))/D1**2
      DFX(=D1+D2
      DIV=FXK/DFXK
      X(=XK-DIV
      IP=IP+1
      Z=ABS(DIV/X()
      IF((Z.LE..000001).OR.(IP.EQ.20)) GO TO 6
      GO TO 5
    6 XCB=X(
      IF (CX.LE..2) YCB=A2AAU*XK+B2BBU*XK2+C2CCU*XK3
      IF(CX.LE..8) YCB=AAAAJ*(4./3.*XK+8./3.*XKH-4.*X(2)+BBBBU*XK
     X +CCCCU*XKS
      IF (CX.GT..8) YCB=A8J+B8U*X(+C8J*XK2+D8U*XK3
      RETURN
      END
```

```
      SUBROUTINE ARCS2(S2,XC,YC)
      COMMON/FOILEND/XXDD,YYDD
      COMMON/UPPER/A2AAJ,B2BBJ,C2CCJ,AAAAJ,BBBBU,CCCCJ,A8U,B8J,C8U,D8U
C  XXDD IS THE ENDPOINT OF THE UPPER FOIL OFFSET
      CXDD=XXDD
      XHIGH=0.
      XLOW=0.
      XINCRT=(CXDD-XC)/50.
      IF (XINCRT.LE.0.) XINCRT=-XINCRT
      IS1I2=1
      S2=0.
      DO 24 IINC=1,50
      XLOW=XHIGH
      XHIGH=XLOW+XINCRT
      CALL ARCLEN(S,XLOW,XHIGH,IS1I2)
   24 S2=S2+S
      RETURN
      END
```

```
      SUBROUTINE ARCLEN(XSS,XL,XH,IS1I2)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LP99,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFAI,GAMMA
      COMMON        SBETA,KK9,ICPI,SARCDJ(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),      DLE,ERC,YYY,XM,ITERA,SXSIO(8),SXSIOO(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCJ(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XJX
      COMMON XRJJND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      DIMENSION T(100),W(100),F(100)
      N=NGAUS
      DO 5 J=1,N
      T(J)=TGAUS(J)
    5 W(J)=WGAUS(J)
    1 SJ9=0.
      DO 2 J=1,N
      CALL FC2(T(J),F(J),XL,XH,IS1I2)
    2 SUM=SU9+W(J)*F(J)
      XSS=SJ9
      RETURN
      END
```

```
      SUBROUTINE FC2(T,F,K,XH,IS1I2)
      COMMON/UPPER/A2AAU,B2BBU,C2CCU,AAAAJ,BBBBU,CCCCU,A8U,B8U,C8U,D8U
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITV(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON       SBETA,KKM,ICPI,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),     CLE,ERC,YYY,XM,IFERA,SXSID(8),SXSIDO(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TBAUS(100),NBAUS(100),NBAUS
      IICONT=1
      XP=(XH-XL)*T+.5*(XH+XL)+.5
      SXP=SQRT(XP)
      XP2=XP**2
      IF(XP.GE..8) GO TO 1
      IF(XP.GE..2.AND.IICONT.EQ.1) GO TO 4
      IF(XP.LE..2)  GO TO 3
      P1=(4./3.*4.*SXP-4.*XP)*AAAA
      P2=BBBB
      P3=.5*CCCC/SXP
      IF (IS1I2.EQ.1) P1=(4./3.*4.*SXP-4.*XP)*AAAAU
      IF (IS1I2.EQ.1) P2=B2BBU
      IF (IS1I2.EQ.1) P3=.5*CCCCU/SXP
      GO TO 2
    3 P1=-.5*SQRT(2.*XROUND)/SXP+A2AA
      P2=B2BB*SXP+1.5
      P3=2.*C2CC*XP
      IF (IS1I2.EQ.1) P1=-.5*SQRT(2.*XROUND)/SXP+A2AAJ
      IF (IS1I2.EQ.1) P2=B2BBU*SXP+1.5
      IF (IS1I2.EQ.1) P3=2.*C2CCJ*XP
      GO TO 2
    4 CONTINUE
      P1=A2AA
      P2=2.*B2BB*XP
      P3=3.*C2CC*XP2
      IF (IS1I2.EQ.1) P1=A2AAU
      IF (IS1I2.EQ.1) P2=2.*B2BBJ*XP
      IF (IS1I2.EQ.1) P3=3.*C2CCU*XP2
      GO TO 2
    1 P1=B8
      P2=2.*C8*XP
      P3=3.*D8*XP2
      IF (IS1I2.EQ.1) P1=B8U
      IF (IS1I2.EQ.1) P2=2.*C8J*XP
      IF (IS1I2.EQ.1) P3=3.*D8U*XP2
    2 P4=P1+P2+P3
      P42=P4**2
      P5=1.+P42
      SP5=SQRT(P5)
      F=(XH-XL)*SP5*.5
      RETURN
      END
```

```
      SUBROUTINE BBBETA(XX,RBETA,IS1I2)
C THIS GIVES BETA(X(XSI)).
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAMX(100),CAMY(100),BETAB,BETAC,XCCC,NCAM,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN1(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON        SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),      CLE,ERC,YY,KM,ITERA,SXSID(9),SXSIDO(9),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      ER1=5.E-3
      ER2=5.E-3
      IF(IS1I2.EQ.1) GO TO 20
C IS1I2=0 FOR S1.
C       1 FOR S2.
      LPMAA=LPM-1
      SMALS=SARC(LP)
      IF(LP.EQ.LPM) GO TO 10
      DSS=SARC(LP)-SARC(LP+1)
      X_PA=XX
      GO TO 21
   20 SMALS=SARC2(LP)
      IF(LP.EQ.1)GO TO 110
      X_PA=XX
      DSS=SARC2(LP)-SARC2(LP-1)
   21 CONTINUE
      X1A=X_PA
    4 X1B=X1A+.001
      CALL FARC(FAR,XLPA,X1B,IS1I2)
      IF(FAR.LT.0.) GO TO 3
      X1A=X1B
      GO TO 4
    3 CALL MOSEC(X1A,X1B,ER1,ER2,XX,JII,X_PA,IS1I2)
      GO TO 11
   10 XX=0.
      GO TO 11
  110 XX=XCCC
   11 CALL SHAPE(XX,Y,RBETA,IS1I2)
      RETURN
      END
```

```
      SUBROUTINE FARC(FAR,XLPA,X13,IS1I2)
      COMMON YCCC,SBETA2
      COMMON XITN(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPNN,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DBAP,ALFA1,GAMA
      COMMON       SBETA,XXM,ICPI,SARCOO(513)
      COMMON IOUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(8),     CLE,ERC,YYY,XM,ITERA,SXSIO(8),SXSIOO(8),YXS(8)
      COMMON PSIZ,LP,SARC(513),SARCJ(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),KJJ(200),XJK
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TBAUS(100),JGAUS(100),NGAUS
      IF(XLPA.EQ.X1B) GO TO 1
      CALL ARCLEN(XSS,XLPA,X1B,IS1I2)
      GO TO 2
    1 XSS=0.
    2 CONTINUE
      FAR=DSS-XSS
      RETURN
      END
```

```
      SUBROUTINE MOSEC(A,B,ER1,ER2,X,J,XLPA,IS1I2)
      J=0
      X1=A
      X2=B
    4 J=J+1
      IF(J.GE.800) GO TO 9
      CALL FARC(PFX1,XLPA,X1,IS1I2)
      CALL FARC(PFX2,XLPA,X2,IS1I2)
      X3=X1+(X2-X1)*PFX1/(PFX1-PFX2)
      CALL FARC(PFX3,XLPA,X3,IS1I2)
      IF(PF(3))1,2,3
    1 X2=X3
      X1=X1
      IF(A-B)10,10,11
   10 Y=X3-ER1
      IF(Y.LE.0.) Y=0.
      GO TO 12
   11 Y=X3+ER1
   12 CALL FARC(PFY,XLPA,Y,IS1I2)
      IF(PFY) 5,2,2
    3 X1=X3
      X2=X2
      IF(A-B) 20,20,21
   20 Z=X3+ER1
      GO TO 22
   21 Z=X3-ER1
   22 CALL FARC(PFZ,XLPA,Z,IS1I2)
      IF(PFZ)2,2,3
    5 GO TO 4
    2 PP= ABS(PFX3)
      IF(PP-ER2) 6,6,4
    6 X=X3
      GO TO 7
    9 WRITE(6,9) J
    9 FORMAT(1X,2HJ=,I3)
      STOP
    7 RETURN
      END
```

vv

```
      FUNCTION AITKEN(XX,YY,X,N)
      DIMENSION XX(1),YY(1),ZZ(21)
      IF (N)1,1,2
    1 AITKEN=YY(1)
      RETURN
    2 IF (N.GT.20) N=20
      M=N+1
      DO 3 K=1,M
    3 ZZ(K)=YY(K)
      DO 4 I=1,N
      DO 4 J=I,N
    4 ZZ(J+1)=ZZ(I)+(X-XX(I))*(ZZ(J+1)-ZZ(I))/(XX(J+1)-XX(I))
      AITKEN=ZZ(N+1)
      RETURN
      END
```

```
      SUBROUTINE DETERM (A,N,D)
C   DETERM  REVISED 02-28-73
      REAL M
      DIMENSION A(50,50),SAVEA(50,50)
      IF (N .EQ. 1)GO TO 46
      C = 1.
      NN = N
      DO 9 J = 1,NN
      DO 9 I = 1,NN
    9 SAVEA(I,J) = A(I,J)
      K = 1
      GO TO 13
   12 K = K + 1
   13 I = K + 1
      L = K
      GO TO 17
   16 I = I + 1
   17 IF (ABS(SAVEA(I,K)) .GT. ABS(SAVEA(L,K))) L = I
      IF (I .NE. NN)GO TO 16
      IF (L .EQ. K)GO TO 28
      J = K
C     ROW INTERCHANGE
      GO TO 23
   22 J = J + 1
   23 SAVEKJ = SAVEA(K,J)
      SAVEA(K,J) = SAVEA(L,J)
      SAVEA(L,J) = SAVEKJ
      IF (J .NE. NN)GO TO 22
      C = -C
   28 I = K + 1
      GO TO 31
   30 I = I + 1
   31 CONTINUE
      IF (SAVEA(K,K) .EQ. 0.) GO TO 48                          02-20-73
      M = SAVEA(I,K) / SAVEA(K,K)
      SAVEA(I,K) = 0.
      J = K + 1
      GO TO 36
   35 J = J + 1
   36 SAVEA(I,J) = SAVEA(I,J) - M * SAVEA(K,J)
      IF (J .NE. NN)GO TO 35
      IF (I .NE. NN)GO TO 30
      IF (K .NE. (NN-1))GO TO 12
      D = 1.
      DO 43 I = 1,NN
      J = I
      D = D * SAVEA(I,J)
      IF (ABS(D) .LT. 1.E-36) GO TO 48
   43 CONTINUE
      D = D * C
      RETURN
   46 D = A(1,1)
      RETURN
   48 D = 0.
      WRITE (6,51)
   51 FORMAT(//5X,'ERROR MESSAGE FROM DETERM.'/
     1 5X,'MATRIX IS SINGULAR. DETERMINANT SET = 0.' //)
      RETURN
      END
**
```

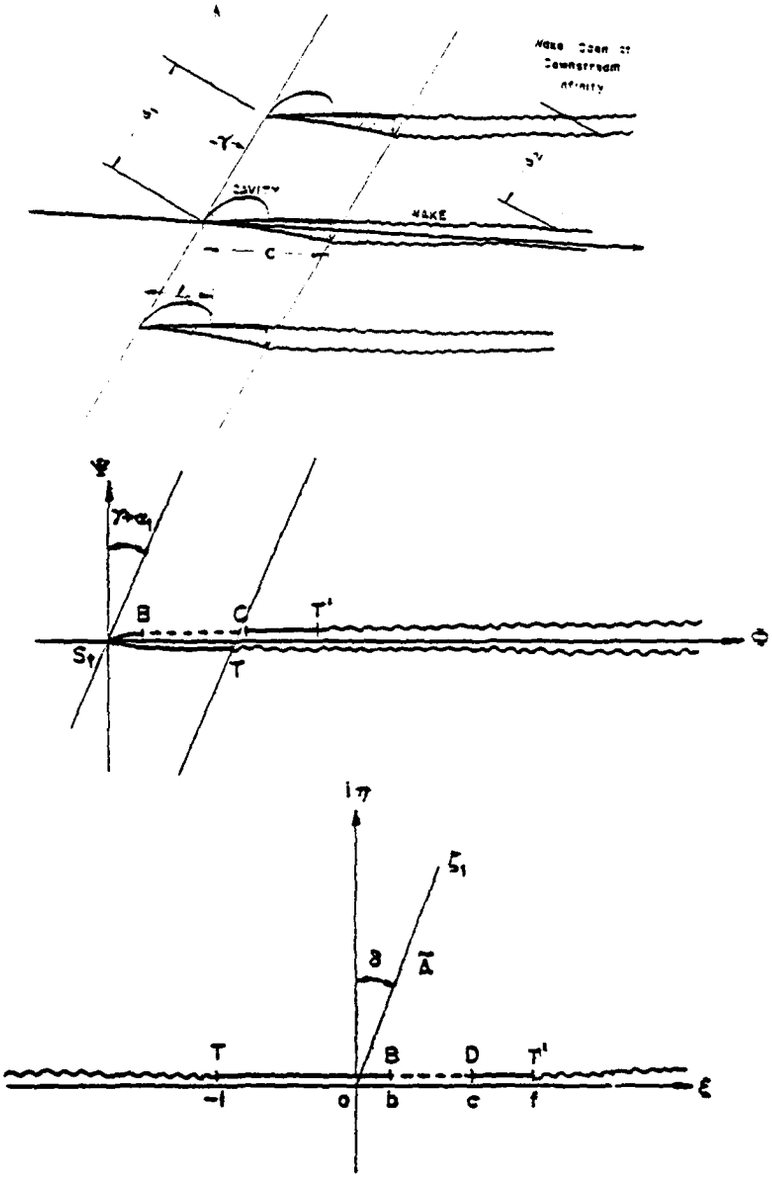

Figure 1 · Open Wake Model for PCASE and PCASLE

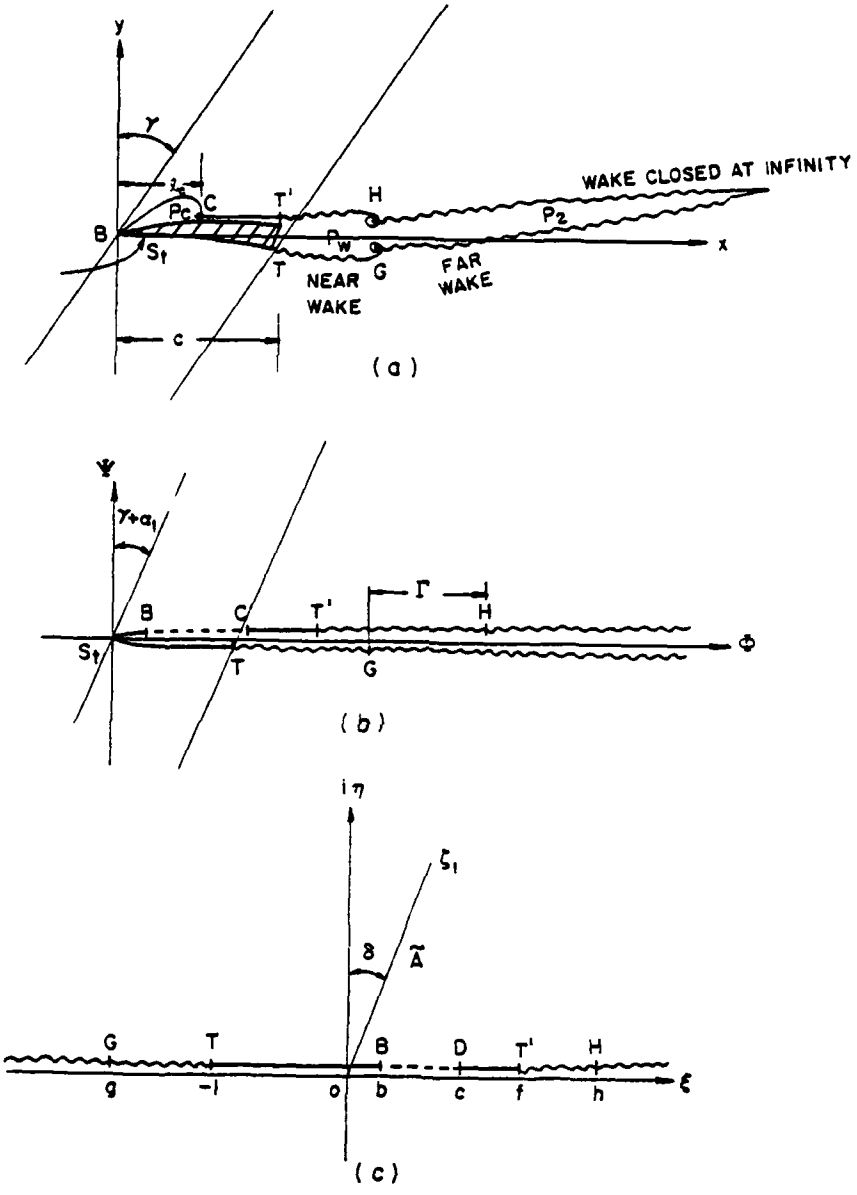

Figure 2 Double Wake Model for PCASLDW

8.0 REFERENCES

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2. Furuya, O., July 1978, "Calculations of the Off-Design Performance for Hydronautics SC Propeller (Model No. 7607.02)", Tetra Tech Report TC-3913.

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